# REPORT TO CONGRESS

## AMERICA'S NEXT GENERATION WEATHER AND SPACE WEATHER SATELLITE SYSTEMS

## 5-YEAR PROFILE (FISCAL YEARS 2025 - 2029)

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*Developed pursuant to: House Report 117-97 accompanying the Consolidated Appropriations Act, 2022 (Public Law 117-103)*

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THE HOUSE REPORT 117-97 ACCOMPANYING THE CONSOLIDATED APPROPRIATIONS ACT, 2022 (PUBLIC LAW 117-103) INCLUDED THE FOLLOWING LANGUAGE

*America's Next Generation Weather Satellite System. —The Committee supports NOAA's next generation weather architecture plan, as developed through the NOAA Satellite Observing System Architecture (NSOSA) study and recognizes that many of that study's recommendations are included in the request. The recommendation directs NOAA to provide the Committee with a five-year budget plan that outlines how it intends to fully develop NSOSA. This plan shall be submitted to the Committee not later than 270 days after the enactment of this Act.*

THIS REPORT RESPONDS TO THE REQUEST.

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# I. EXECUTIVE SUMMARY

The National Oceanic and Atmospheric Administration (NOAA) undertook the NOAA Satellite Observing System Architecture (NSOSA) study between 2014 to 2017. The purpose of the NSOSA study was to evaluate alternative architectures and plan for an operational environmental satellite system that would begin in the late 2020s. The study estimated costs for multiple cycles of development, construction, launch, and operations needed to potentially sustain operations through 2050. The NSOSA study was bound by six strategic objectives that were used to measure the overall performance of future weather satellite constellations. For the purposes of the NSOSA report, a strategic objective reflects a concern that does not involve collecting environmental data or providing a functional service. Strategic objectives reflect the assurance that critical services are provided or that there is the ability to flexibly adapt capabilities over time. These objectives include: 1) assure core capabilities; 2) be compatible with stable budgets; 3) assure all capabilities; 4) prioritize programmatic flexibility and adaptability; 5) develop and maintain international partnerships; and 6) maintain low risk at the constellation level.

The NSOSA study served as a NOAA National Environmental Satellite, Data, and Information Service (NESDIS) enterprise planning framework that offered nearly 200 flight architectures that characterize alternatives across a range of costs with the ability to defer decisions on which capabilities to buy over time. The study outlined an approach that compared the estimated cost and performance features of the flight segment of a variety of observing systems and, included with other options, a continuance of the current legacy systems. The NSOSA study provided diverse options for an adaptable, responsive, cost effective, and high-quality satellite observing system to meet NOAA's mission and objectives for the future. NOAA used the information from the NSOSA study, with cooperation from foreign and domestic partners, as a guide for future satellite architecture and plans.

NOAA then developed an implementation plan based on findings from the NSOSA study and from requirements validated by the NOAA Observing Systems Council. NOAA's implementation plan is reflected in the President's Fiscal Year (FY) 2025 Budget request and is explained in detail in the 2023 *Report on Requirements of NOAA's Next-Generation Satellites*. Appendix B provides reference documents used to develop this congressional report.

This report reflects NOAA's planned activities for its next-generation satellites as outlined in NOAA's FY 2025 President's Budget request. The FY 2025 Budget makes the critical investments necessary to maintain the development timelines for the most mature next generation satellite programs to expand delivery of essential climate, weather, atmospheric, oceanographic, and space weather information to meet the needs of the Nation. Funding profiles will be updated as the programs complete their acquisition milestone reviews.

**Table 1. 5-Year NextGeneration Funding Estimates ($M)***

| PPA/Constellation | FY 2024 & Prior | FY 2025 Request | FY 2026 estimate | FY 2027 estimate | FY 2028 estimate | FY 2029 estimate | Cost To Complete (CTC) | Total |
|---|---|---|---|---|---|---|---|---|
| GEO: GeoXO | $729.4 | $798.4 | $691.5 | $1,320.0 | $1,320.0 | $1,320.0 | $13,465.1 | $19,644.4 |
| LEO: NEON ** | $193.8 | $68.4 | $200.0 | $200.0 | $200.0 | $200.0 | TBD | TBD |
| SW Next ** | $358.2 | $236.8 | $231.2 | $231.2 | $231.2 | $231.2 | TBD | TBD |
| Common Ground Services | $310.7 | $120.5 | $131.3 | $131.3 | $131.3 | $131.3 | N/A | N/A |

** Outyears are estimates. Future requests, submitted through the annual budget process, may reflect necessary rephasing in order to adjust for enacted Congressional appropriations.*
*** The funding profile relative to program scope and schedule will be continuously evaluated as the program progresses through future milestone reviews.*

## II. CONTEXT FOR NOAA's NEXT GENERATION REPORT

### A. NOAA's Satellite Constellation

NOAA initiated the NSOSA study after assessing various factors, including: its historical satellite acquisition program; the increasing maturity of the U.S. aerospace sector to accomplish work that had traditionally been the government's purview, along with long outstanding and unmet requirements from NOAA Line Offices and users; new technologies and emerging space business models; directives from the Congress; and unmet recommendations from various National Academy of Sciences Decadal Studies.

The NSOSA study considered nearly 200 different constellations, organized on varying themes, such as satellite disaggregation versus aggregation, platform hybridization, and exploitation of non-traditional orbits versus traditional orbit maintenance.

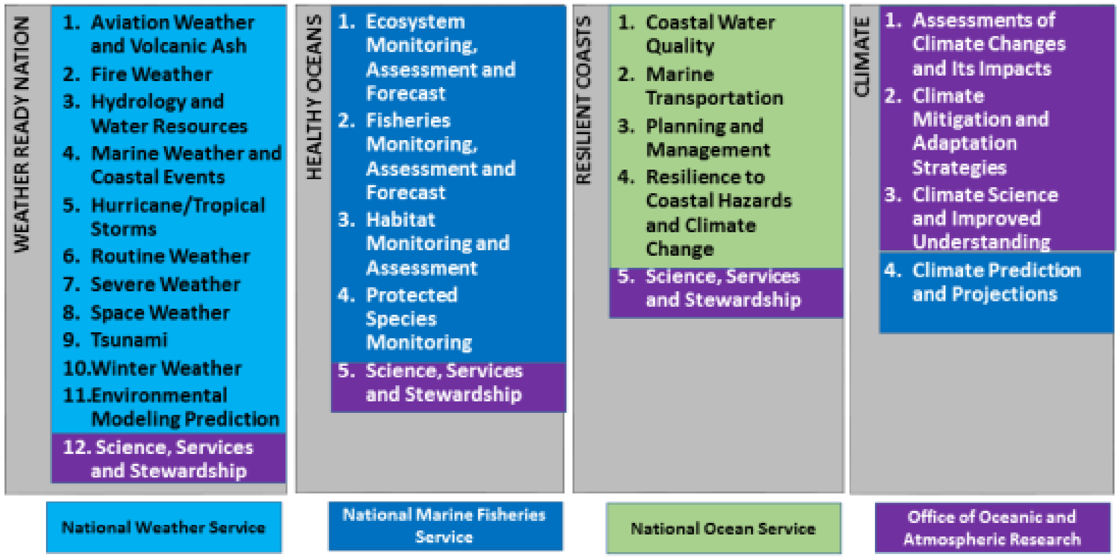


**Figure 1. NOAA Mission Service Areas (shown below) were used to prioritize observing system needs and develop Program requirements.**

## B. NOAA's Six Strategic Objectives and Development of the Four Pillars

Six strategic objectives were identified to be included as value factors in assessing the overall performance of a satellite constellation. The objectives were:

- **Assure Core Capabilities** – Establish the highest assurance (availability) level for mission critical capabilities: real time regional weather imagery and global near real-time soundings.
- **Be Compatible with Stable Budgets** – Favor space architectures that do not require extreme peaks or valleys in total funding.
- **Assure All Capabilities** – Establish moderate assurance (availability) of all non-core capabilities.
- **Prioritize Programmatic Flexibility and Adaptability** – Favor space architectures that allow for more capability on-ramps (e.g., to take advantage of new technology) and off-ramps (e.g., to take advantage of emergent partners or commercial capabilities).
- **Develop and Maintain International Partnerships** – Make use of and encourage greater access to available international partner data to optimize mission impact of NOAA resources.
- **Maintain Low Risk at the Constellation Level** – Allow tolerance for risk associated with new business models and technology for individual capabilities by managing observing system reliability at the constellation level.

NOAA developed the four pillars of the next generation satellite architecture that would ensure continuity of services and introduce new capabilities aimed at meeting NOAA Line Office and Program requirements.

The Four Pillars constitute the basis of NOAA's next generation satellite architecture, as discussed in the Report to Congress, *Report on Requirements of NOAA's Next-Generation Satellites*.

**Integrated, Adaptable, and Affordable: Orbits, Instruments & Systems**

**LEO**

Maintain critical global observations and partnerships yielding high accuracy long-range forecasts, including storms, floods and fires. New systems will utilize next-generation instruments launched on single payload satellites, embracing agile, "new space" commercial processes.

**GEO**

Continuous real-time observations supporting warnings and watches of severe weather and hour-by-hour changes. Monitoring of oceans, atmosphere, and climate to improve productivity and health outcomes.

**Space Weather**

Reliably monitoring coronal mass ejections from L1, GEO, and LEO can protect the nation's valuable, vulnerable infrastructure. New capabilities at L5 and high earth orbit can provide additional insight and improve forecasts.

**Common Ground Services**

Secure ingest of data in different formats from different partners requires a flexible, scalable platform. Common Services approach integrates cloud, AI, and machine-learning capabilities to verify, calibrate, and fuse data into new and better products and services.

**Figure 2. The Four Pillars of NOAA's Next Generation Observation System**

## III. STRATEGIES FOR IMPLEMENTING NOAA's NEXT GENERATION SATELLITE ARCHITECTURE

The development of NOAA's next generation satellite architecture will be based on an assessment of user needs in order to continually evaluate and optimize NESDIS' requirements and determine whether these needs could be met through leveraging data from national and international sources, commercial partnerships, and academic sources.

NOAA's Systems Architecture and Engineering (SAE) office leads the systems engineering and project management policies and procedures that guide NESDIS's enterprise approach to developing and maintaining NOAA's environmental satellites, ground systems, and services. Based on validated requirements, SAE supports engineering and modeling assessments that support the decision-making whether a NOAA government build is the most cost-effective means to meet these requirements, or whether the industry and partner satellite data products and services are sufficiently reliable for operational use by NOAA Line Offices and partners.

To accomplish these goals, SAE:

- Oversees Joint Venture Partnerships, which collaborates with U.S. Government agencies, international partners, and industry to leverage technology development to meet NOAA mission needs.
- Conducts long term ground and satellite architecture studies to identify cost-effective options for developing future remote-sensing and data services systems.
- Manages the Commercial Data Program (CDP), which evaluates and acquires commercially provided satellite data to augment government sources. CDP routinely solicits via SAM.gov and through consultations with the commercial industry for information on plans and capabilities for meeting NOAA’s data requirements.

NOAA currently relies on the commercial sector to build its instruments and spacecraft buses. There is evidence that the maturity of the commercial sector is evolving and NOAA could rely on commercial partners to provide additional services. Certainly, between now and 2050, NOAA anticipates more opportunities to rely on commercial partners. GEO, LEO, and SWO program offices also work very closely with the commercial partners that are building the instruments, spacecraft buses, algorithms, and ground segments on capabilities that NOAA can leverage to meet its needs.

NOAA also relies upon domestic and international partnerships to meet goals:

- There is significant dialogue among NOAA, NASA, the U.S. Department of the Interior, and the Department of Defense’s Space Force and U.S. Navy on joint activities that further our individual goals to share data, information and strategies that support U.S. civil and military defense requirements. Dialogue occurs between agencies as well as under the auspices of the Office of Science and Technology Policy and the National Space Council.
- NOAA actively engages with international partners through fora such as the World Meteorological Organization, Group on Earth Observations, Committee on Earth Observation Satellites, Coordination Group for Meteorological Satellites, and other international gatherings that coordinate to share plans and develop mutually beneficial cooperation.
- NOAA has a number of bilateral agreements with other national space agencies to actively leverage data that supplement the foundational data produced by NOAA’s GEO, LEO, and space weather systems.

As NOAA implements the next generation satellite architecture, which was informed by NSOSA, it will maximize the opportunities that these relationships provide.

## IV. NOAA NEXT GENERATION CONSTELLATION

The 2023 *Report on Requirements of NOAA’s Next-Generation Satellites* provides further details on NOAA’s 10-year plan to acquire observations under the Offices of Geostationary Earth Orbit Observations, Low Earth Orbit Observations, and Space Weather Observations.

## A. Office of Geostationary Earth Orbit (GEO) Observations: Geostationary Extended Observations (GeoXO) Program

**Relationship to the NSOSA Study**

Among a wide range of potential alternatives, NSOSA narrowed the trade space for geostationary observations to the highest-value architectures and recommended that NESDIS further evaluate three options. These included: a constellation that occupied both geostationary and tundra orbits and included Earth and space weather observations; a geostationary-only constellation with Earth and space weather observations; and a disaggregation of the Earth and space weather capabilities. NSOSA also recommended that NESDIS evaluate options for use of commercial services, specifically commercial communications services for all rebroadcast services and payload hosting. The planned GeoXO constellation meets the suggestions of the "hybrid architecture" constellation while building off of the legacy platform of the GOES-R Series.

The GeoXO program aligns with the ranking of key observations as identified by the NSOSA study. The GeoXO constellation addresses four of the six geostationary based Earth-observing objectives, including real-time regional weather imagery, and real-time regional infrared (IR) soundings, lightning imagery, and ozone measurements.

The GeoXO pre-formulation phase included extensive user outreach – to thousands of end users in dozens of organizations – to define future observational needs and select the recommended payload instruments for GeoXO. The importance of these products was validated through engagement with NOAA Line Offices (National Weather Service, National Marine Fisheries Service, National Ocean Service, and Office of Oceanic and Atmospheric Research) where four challenges were identified: harmful algal blooms, wildfires, air quality, and numerical weather prediction (NWP). Priorities were also identified by each Line Office related to weather, oceans, coasts, and climate mission service areas. The GeoXO instrument suite was designed to best meet NOAA's observational requirements in a cost-effective manner, meeting both existing requirements and anticipating growing needs. This includes the addition of three new instruments, including a Hyperspectral Sounder, which will improve numerical weather prediction models. In addition, an Atmospheric Composition Instrument and Ocean Color Instrument will provide further new data on air pollution and marine conditions, respectively.

In its pre-formulation phase between 2019 and 2021, NESDIS evaluated these NSOSA recommendations and further refined the trade space. A GEO architecture was chosen that makes selective use of commercial services as the program baseline, and which moves the space weather observations to a stand-alone NESDIS program element, in the SWO portfolio. NESDIS further concluded that the tundra orbiting observations should not be included in the baseline GEO plan due to cost and the limited additional operational impact of the observations to meet NOAA's mission. The GeoXO constellation maintains the east and west satellite locations with the addition of a third central satellite capable of hosting a partner payload (Figure 3). This allows these large and complex satellites to continue to host the instruments necessary to collect critical weather and climate data, while allowing for flexibility. It should be noted that although the GeoXO constellation is capable of hosting a partner payload, no payload partnerships have yet been identified ahead of the 2032 anticipated launch date.

**GeoXO 5-Year Funding Estimates**

The GeoXO Program, managed by the Office of GEO Observations, is NOAA's plan to address the next generation satellite architecture and will provide continuity of observations, services, and planned enhancements following the GOES-R Series.

**Table 2. 5-Year GeoXO Funding Estimates ($M)***

| PPA/ Constellation | FY 2024 & Prior | FY 2025 PB | FY 2026 est. | FY 2027 est. | FY 2028 est. | FY 2029 est. | CTC | Total |
|---|---|---|---|---|---|---|---|---|
| GEO: GeoXO | $729.4 | $798.4 | $691.5 | $1,320.0 | $1,320.0 | $1,320.0 | $13,465.1 | $19,644.4 |

* *Estimates are subject to change and refinement through the annual budget process.*

NOAA's GeoXO satellite program will serve as the next generation of space-based environmental monitoring observatories, providing essential, sustained observations from the geostationary orbit to meet NOAA mission needs. GeoXO will supply vital information to address major environmental challenges of the future in support of U.S. weather, ocean, and climate operations. NOAA is working to ensure these critical observations are in place by the early 2030s as the GOES-R Series nears the end of its operational lifetime in the mid-2030s. The GeoXO system is planned to provide observations through 2055. The six-satellite GeoXO program will continue and expand observations provided by the GOES-R Series and bring new capabilities to bear that address emerging environmental issues and challenges that threaten the security and well-being of every American. Weather and environmental observations provided by GeoXO satellites will support NOAA's Strategic Plan 2022-2026 objectives by building a more climate-ready nation and helping advance the New Blue Economy.

The GeoXO program will provide improved performance of existing imager and Geostationary Lightning Mapper (GLM) instruments. The GeoXO program will also introduce new instruments to meet emerging requirements, such as local nowcasting; monitoring of coastal and ocean features and ecosystem change; and monitoring air quality. NOAA plans to include the following instruments on GeoXO: Imager, Hyperspectral Infrared Sounder, Lightning Mapper, Atmospheric Composition, and Ocean Color.

The follow-on for geostationary orbit space weather instruments and observations hosted on the GOES-R Series platform will not be included in the GeoXO program. Those requirements have been transferred to the Office of Space Weather Observations (IV.C).

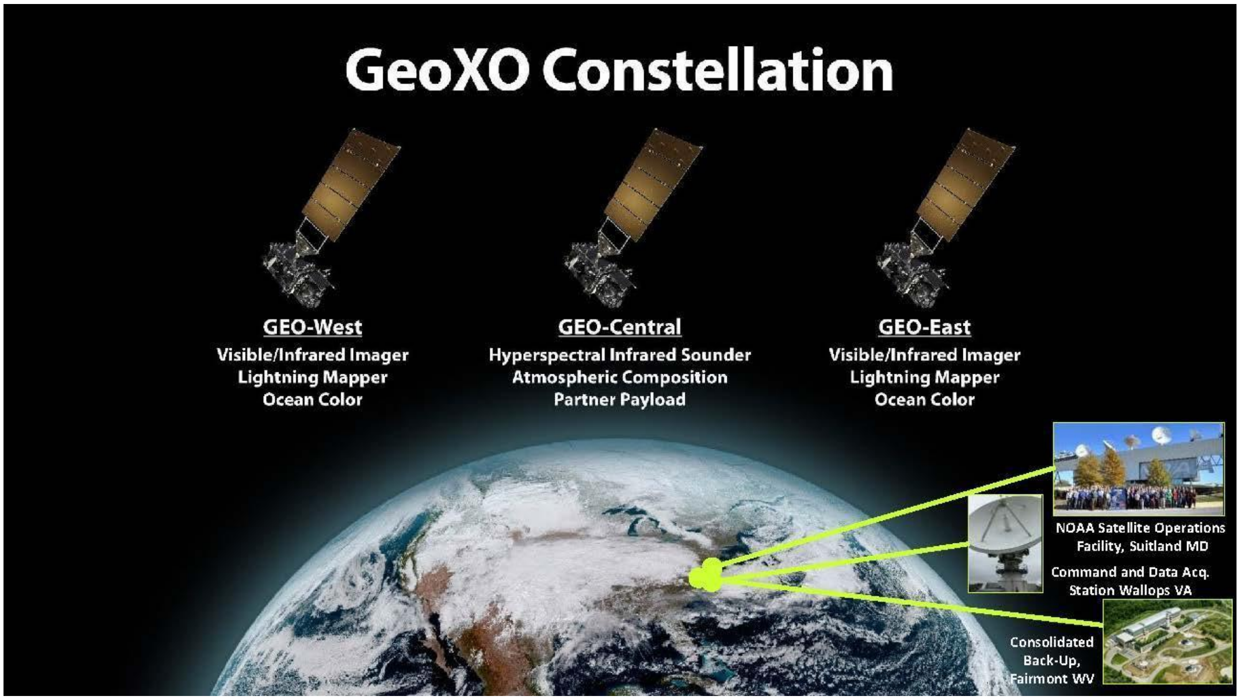


**Figure 3. Planned GeoXO Constellation.**

## B. Office of Low Earth Orbit (LEO) Observations: Near Earth Orbit Network (NEON) Program

**<u>Relationship to the NSOSA Study</u>**

The NSOSA study recognized the critical observations provided in low Earth orbit, particularly the global atmospheric soundings and other observations that serve as the backbone of global NWP models. In low Earth orbit, the NSOSA study recommended a moderate level of disaggregation, more opportunities for variation in instrument technology, and outsourcing where possible to commercial data and services to meet mission needs. In addition, the study identified six priorities for low Earth orbit, where additional global observations could reduce the impact of severe weather and water events through improved prediction and warning. Those priorities are:

(1) assurance and orbital diversity of soundings;
(2) continue to meet NESDIS observational requirements for radio occultation soundings;
(3) three dimensional atmospheric winds;
(4) low light imaging in multiple orbits;
(5) microwave imaging for surface winds and other products; and
(6) precipitation radar.

Following the recommendations from the NSOSA study, the Office of LEO Observations' NEON Program intends to use a combination of small and medium sized satellite platforms in a semi-disaggregated satellite architecture. Capitalizing on a semi-disaggregated architecture will enable NOAA to strategically exploit technology and production advancements in the commercial aerospace industry. This approach will provide an efficient means of responding to technological gaps rapidly and take advantage of emerging remote sensing technologies. As such, the NEON program is formulated as a loosely coupled program, addressing NOAA objectives through multiple independent projects that each has its own lifecycle cost and assigned requirements. The project management structure of a loosely coupled program allows for iterative development of projects that exploit new technologies and opportunities. This allows for future projects to address new requirements and user needs more rapidly than how NOAA has historically developed a new satellite program, which typically takes 10-15 years.

To obtain the variety and scope of LEO data products that are a part of the current baseline, the NEON Program also relies heavily on U.S. and international partnerships. These partnerships are considered essential for meeting LEO observational needs, including for: (1) expanding the NOAA-owned constellation, lowering the refresh rate on key products, and (2) providing access sensors that NOAA does not build/own, allowing NOAA to generate a wider variety of products for users.

NEON will support continuity of the product baseline generated from observations currently provided by JPSS and current NESDIS partner mission observations from LEO, evolving to support new requirements using partnerships, commercial, or NOAA-developed approaches. The initial program content is focused on exploiting commercial investment, expertise, and innovation in space and space systems technology, and leveraging smaller satellites and launch vehicles. The initial program is also aimed at pursuing the development of next generation microwave and infrared sounders most critical to NWP, and maintaining continuity of key JPSS partnerships. The NEON QuickSounder Project will demonstrate operational observations that can be obtained with a small, commercial-based satellite on a compressed schedule. The NEON Series-1 Project will provide microwave and infrared soundings, developing the next generation of instruments with improved science performance, agility and resiliency over legacy instrument capabilities. These first projects were chosen based on critical capability replenishment need dates, while subsequent projects will enable augmentation of observations in the future.

Expansion of LEO capabilities will hinge on the availability and affordability of commercial partnerships. LEO will continue to work with SAE regarding the CDP program to support LEO observations. Measurements such as radio occultation, 3-D Winds, low-light imagery, and precipitation radar are not scoped as part of a NOAA-owned capability. Partnerships will be assessed should they become available.

**NEON 5-Year Funding Estimates**

The NEON Program, managed by the Office of LEO Observations, is NOAA's plan to address the next generation satellite architecture for low Earth orbit / polar-orbiting satellites that will provide the follow-on to the JPSS Program.

**Table 3. 5-Year NEON Funding Estimates ($M)***

| PPA/ Constellation | FY 2024 & Prior | FY 2025 PB | FY 2026 est. | FY 2027 est. | FY 2028 est. | FY 2029 est. | CTC | Total |
|---|---|---|---|---|---|---|---|---|
| LEO: NEON | $193.8 | $68.4 | $200.0 | $200.0 | $200.0 | $200.0 | TBD | TBD |

** Estimates are subject to change and refinement through the annual budget process.*

NOAA began the formulation of the NEON program, the follow-on to Polar Weather Satellites, in FY 2021. NEON will continue, improve, and extend NESDIS' global observations for weather forecasting and climate monitoring, and include satellites that host Earth-observing instruments. The first NEON mission, QuickSounder, is a demonstration mission intended to leverage advancements that have been made in the commercial aerospace industry to acquire spacecraft and launch vehicles, and perform satellite operations, data receipt/routing and associated ground services, which will help NOAA define its next generation satellite architecture. Additional benefits include improving instrument observational density and mitigating the projected gap in microwave sounding data in the early morning orbit and the early afternoon orbit. Without replacement observations, a gap will occur when the legacy Polar Operational Environmental Satellites (POES) satellites (NOAA-15, NOAA-17, and NOAA-19) are decommissioned and NOAA's JPSS reaches the end of its design life.

The NEON program passed DOC Milestone 1 on March 8, 2024 and was authorized to proceed to the project definition phase. The full scope of the NEON Program has not yet been finalized, however, subsequent NEON missions will be designed to capitalize on lessons learned through QuickSounder. Each project within the NEON program will have an allocated set of program requirements and defined life cycle cost. Combining innovative advances in commercial space and investments through NESDIS' Joint Venture program and anticipating the future capabilities of partnering organizations are key to an affordable NEON program, but have inherent risk and uncertainty. Leveraging domestic and international partnerships will allow NOAA to supplement its core observations from NOAA satellites for a fraction of the cost of acquiring our own satellites. The NEON program will assess and exploit partnership opportunities with U.S. and international partners, such as EUMETSAT, the Japanese Meteorological Agency, NASA, the Department of Defense, the European Space Agency (ESA), and the Japan Aerospace Exploration Agency. The NEON program will also leverage NOAA's CDP – the piloting and purchasing of current and future observations and data from commercial satellites – to supplement its observational portfolio and reduce risk to its program.

## C. Office of Space Weather Observations (SWO): Space Weather Next (SW Next) Program

### Relationship to the NSOSA Study

The NSOSA study recognized the expansion of NOAA's mission to operational space weather, at that time citing the National Space Weather Action Plan (National Science and Technology Council 2015) and stating the importance of space weather forecasting services by the NOAA Space Weather Prediction Center (SWPC) in the form of alerts and warnings. The importance of these observations would be subsequently reaffirmed by congressional directive from the *Promoting Research and Observations of Space Weather to Improve the Forecasting of Tomorrow Act* (Public Law 116-181), the National Space Weather Strategy and Action Plan (March 2019), and the National Academy of Sciences Decadal Studies, which specified NOAA as provider of space weather observational data continuity and enhanced space weather capability.

The NSOSA analysis found that providing resilient continuity and enhanced operational space weather observational capabilities has a very high return in benefit to society. The U.S. economy is ever-more dependent on technologies such as satellite, power grids, high frequency communication and precision global navigation that are potentially impacted by space weather events. NSOSA identified observational capabilities that include on--Sun-Earth-Line (i.e., L1 and geostationary points) and off-Sun-Earth-Line (i.e., L5 or L4) coronagraph imagers and various space weather sensors in multiple orbits.

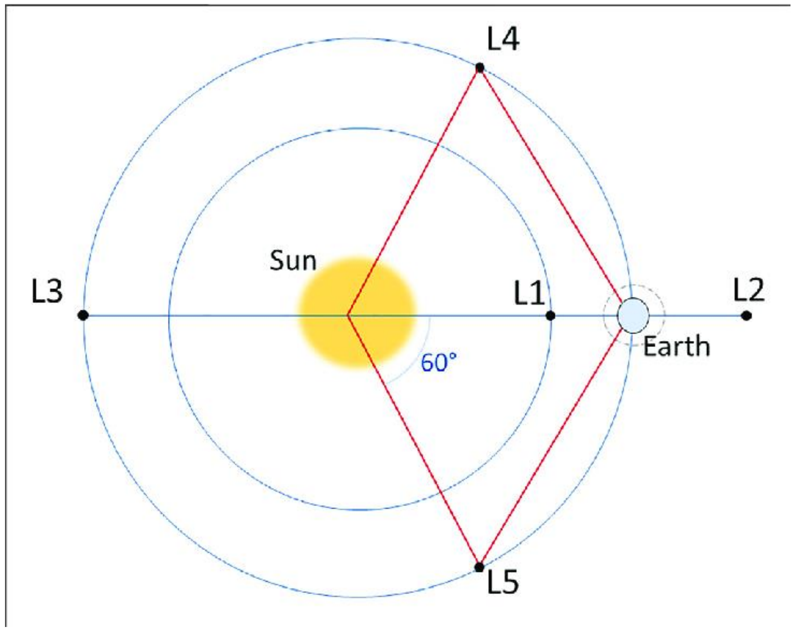


Figure 4. Diagram of the Earth-Sun Lagrange Points

NSOSA recommended that NOAA disaggregate and assign the long-term allocation of space weather instruments in parallel with activities to develop its earth observation architecture (GeoXO and NEON Programs). In this way, NOAA would be able to exploit available *in situ* and on-orbit solar observing platforms. As a loosely-coupled program, SW Next embraces this approach, managing observations across multiple individual projects to be identified and developed over time to satisfy portfolio goals and requirements.

In formulation, the SW Next Program has already concurred with and employed multiple NSOSA findings in its conceptual architecture. SW Next will pursue space weather capabilities in multiple orbits, including at Lagrange Point 1 (L1) and Lagrange Point 5 (L5). To occupy these orbits, SW Next will leverage international partnerships and explore commercial opportunities for hosting. NOAA's CDP continues to support space weather studies to assess the quality and operational impact of space weather data from industry. CDP will also include assessing the commercial sector's ability to meet NOAA's critical space weather forecasting requirements in its annual requests to industry. Finally, SW Next addresses the need for near-term replenishment and continuity of critical observations beyond current space weather programs of record, while also allowing for the augmentation of additional critical observations when available.

**SW Next 5-Year Funding Estimates**

SW Next, managed by the Office of SWO, is NOAA's plan to address the next generation satellite architecture for space weather observations that will provide the required operational follow-on to the Space Weather Follow-On L1 (SWFO-L1) mission.  Launch of the SW Next L1 Series project (L1 Series) is required to provide continuity of DSCOVR, and the SWFO-L1 spacecraft as it reaches the end of its design life in the early 2030s. SW Next will also assume responsibility for continuity of legacy space weather measurements currently provided by NOAA's GOES-R Series and POES.

SW Next is a loosely coupled program, utilizing an innovative portfolio management approach which allows for individual "projects" to be developed over time to satisfy portfolio goals and requirements. SW Next's projects include an L1 Series continuity project, a L5 project (also referred to as ESA Vigil) in partnership with the ESA that will provide off-Sun-Earth-Line observations, and potentially observations from GEO, LEO, and other orbits, as appropriate to meet the NOAA mission need in the most cost-effective manner. The L1 Series project will sustain and continue the coronal mass ejection (CME) and solar wind measurements established by SWFO. The addition of L5 observations will improve arrival and duration forecasts of CMEs. This will increase lead time and confidence in the predicted solar wind that will arrive at Earth, and provide characterization of interactions with Earth's magnetosphere (e.g., direct-hit, glancing blow, etc.). The suite of observations from L1, L5, and other potential orbits is expected to allow for the detection, tracking, and characterization of CMEs, solar flares, and other space weather activity. The observations provide critical information to accurately model, predict, and provide early warnings of solar radiation storms and geomagnetic storms on Earth to protect lives and property.

**Table 4.  5-Year SW Next Funding Estimates ($M) ***

| PPA | FY 2024 & prior | FY 2025 PB | FY 2026 est. | FY 2027 est. | FY 2028 est. | FY 2029 est. | CTC | Total |
|---|---|---|---|---|---|---|---|---|
| SW Next | $358.2 | $236.8 | $231.2 | $231.2 | $231.2 | $231.2 | TBD | TBD |

*  *Estimates are subject to change and refinement through the annual budget process.*

### D. Common Ground Services (CGS)

The foundation of the GEO, LEO, and SWO activities is grounded in the CGS. CGS plans and executes common ground services for NOAA's satellite, data, and information capabilities. Ground services are critical to acquiring, processing, and managing the environmental data from satellite missions and deriving value from the investments other organizations have made in the space segment. CGS facilitates access to non-NOAA domestic and international satellite data, and supports commercially-acquired data.
In collaboration with the National Centers for Environmental Information, CGS also provides long-term archive services for all approved NOAA and external partners' environmental data sources. CGS core responsibilities include: developing and sustaining the NESDIS Common Cloud Framework (NCCF), which facilitates ingesting, processing, and archiving of data from NOAA-managed systems, non-NOAA sources; and product portfolio management to ensure delivery of high priority products aligned with user needs. Consolidating data in the NCCF will significantly enhance access to and usability of NOAA's data, which is expected to grow from 55 to over 1,000 petabytes by 2030. This will also enable NOAA and other users to quickly develop new applications, promote research by the academic community, and facilitate the use of artificial intelligence and machine learning to exploit big data sets. CGS activities also include planning cloud-related acquisitions; sustainment of on-premises systems prior to transition to the cloud; and management, engineering, integration and testing, transition to operations, and overall sustainment of common ground services. In addition, CGS participates in system verification and validation efforts, as well as life cycle reviews for major satellite acquisition programs and projects. CGS will assess and implement new techniques and technologies to make its support of the next generation satellite architecture more efficient.

**Table 5. 5-Year CGS Funding Estimates ($M)**

| PPA | FY 2024 & prior | FY 2025 PB | FY 2026 est. | FY 2027 est. | FY 2028 est. | FY 2029 est. | CTC | Total |
|---|---|---|---|---|---|---|---|---|
| CGS | 310.7 | $120.5 | $131.3 | $131.3 | $131.3 | $131.3 | N/A | N/A |

* Estimates are subject to change and refinement through the annual budget process.

## V. CONCLUSION

NOAA undertook the NSOSA study between 2014 to 2017, which informed development of the next generation architecture that it is now implementing.

The next generation architecture reflects priority observations from NOAA Line Offices and six strategic objectives, implements congressional directives, and the National Academy of Sciences recommendations. Funding to implement the objectives recommended by NOAA's NSOSA plan will occur through the annual budget formulation process. This report covers 5 years (2025-2029) of the total planned implementation through 2050.

## APPENDIX A: LIST OF ACRONYMS

| | |
|---|---|
| CMEs | Coronal Mass Ejections |
| CDP | Commercial Data Program |
| CGMS | Coordination Group for Meteorological Satellite |
| CTC | Cost to Complete |
| CGS | Common Ground Services |
| DOC | Department of Commerce |
| DSCOVR | Deep Space Climate Observatory |
| ESA | European Space Agency |
| FY | Fiscal Year |
| GEO | Geostationary Earth Orbit |
| GeoXO | Geostationary Extended Observations |
| GLM | Geostationary Lightning Mapper |
| GOES-R | Geostationary Operational Environmental Satellite-R |
| IR | Infrared |
| JPSS | Joint Polar Satellite System |
| L1 | Lagrange Point 1 |
| L5 | Lagrange Point 5 |
| LCC | Life-Cycle Costs |
| LEO | Low Earth Orbit |
| NASA | National Aeronautics and Space Administration |
| NCCF | NESDIS Common Cloud Framework |
| NCEI | National Centers for Environmental Information |
| NEON | Near Earth Orbit Network |
| NESDIS | National Environmental Science, Data, and Information Service |
| NOAA | National Oceanic and Atmospheric Administration |
| NSOSA | NOAA Satellite Observing System Architecture |
| NWP | Numerical Weather Prediction |
| Off-SEL | off the Sun-Earth Line observations |
| POES | Polar Operational Environmental Satellites |
| PROSWIFT | Promoting Research and Observations of Space Weather to Improve the Forecasting of Tomorrow Act |
| R2O2R | Research-to-Operations-to-Research |
| SAE | Systems Architecture and Engineering |
| SW Next | Space Weather Next |
| SWFO-L1 | Space Weather Follow-On L1 |
| SWO | Space Weather Observations |
| SWPC | Space Weather Prediction Center |

## APPENDIX B: LIST OF REFERENCES

| Document | Location |
|---|---|
| **NOAA Documents** | |
| FY 2025 Congressional Justification and FY 2025 Blue Book | www.noaa.gov/organization/budget-finance-performance/budget-and-reports |
| 2023 Report on Requirements of NOAA's Next-Generation Satellites | www.nesdis.noaa.gov/s3/2023-06/22-J-833-NOAA-NESDIS-User_Needs_Requirements_and_Lifecycle_Costs_REPORT.pdf |
| 2018 NOAA Satellite Observing System Architecture Study Draft Report | www.regulations.gov/document/NOAA-NESDIS-2018-0053-0002 |
| **National Academies of Sciences** | |
| 2018 Thriving on Our Changing Planet A Decadal Strategy for Earth Observation from Space | http://nap.nationalacademies.org/catalog/24938/thriving-on-our-changing-planet-a-decadal-strategy-for-earth |
| 2013 Solar and Space Physics: A Science for a Technological Society | http://nap.nationalacademies.org/catalog/13060/solar-and-space-physics-a-science-for-a-technological-society |
| 2007 Earth Science and Applications from Space National Imperatives for the Next Decade and Beyond | http://nap.nationalacademies.org/catalog/11820/earth-science-and-applications-from-space-national-imperatives-for-the |
| 2000 Ensuring the Climate Record from the NPP and NPOESS Meteorological Satellites | http://nap.nationalacademies.org/catalog/12263/ensuring-the-climate-record-from-the-npp-and-npoess-meteorological-satellites |
| **Congressional Direction** | |
| Weather Research and Forecasting Innovation Act of 2017 (Public Law 115-25) | www.congress.gov/115/statute/STATUTE-131/STATUTE-131-Pg91.pdf |
| National Integrated Drought Information System Reauthorization Act of 2018 | www.congress.gov/115/plaws/publ423/PLAW-115publ423.pdf |
| Promoting Research and Observations of Space Weather to Improve the Forecasting of Tomorrow Act or the PROSWIFT Act (Public Law 116-181) | www.congress.gov/bill/116th-congress/senate-bill/881 |

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