



# Developing an Integrated Understanding of our Earth Environment

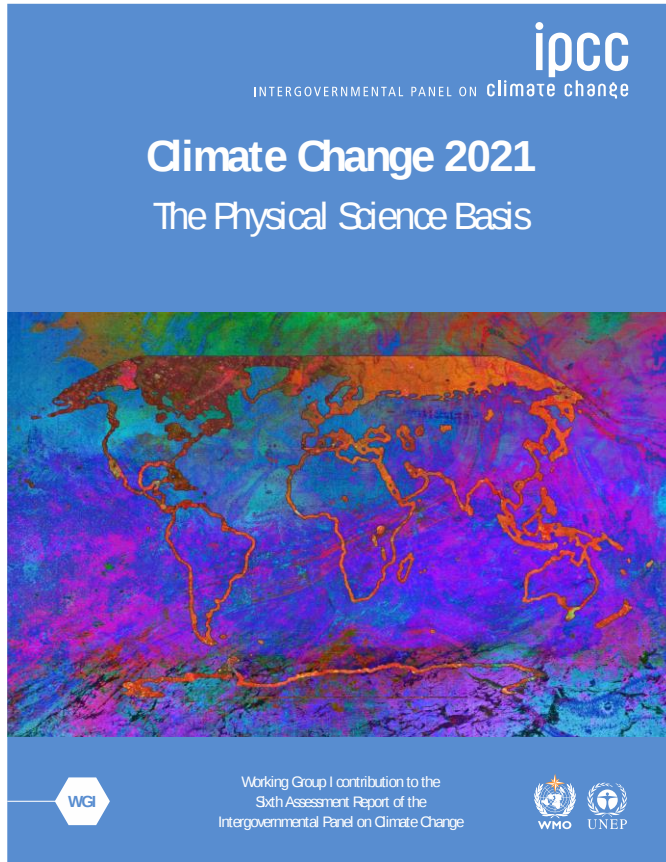
National Environmental Satellite,  
Data, and Information Service

**Briefing to CESAS**  
28 October 2021

**Irene Parker**

NOAA NESDIS Acting Deputy Assistant Administrator for  
Systems, Assistant Chief Information Officer

# 2021 – A Time of Clarity



From the IPCC, August 2021:

***“It is unequivocal that human influence has warmed the atmosphere, ocean and land. Widespread and rapid changes in the atmosphere, ocean, cryosphere and biosphere have occurred.***

***“Human-induced climate change is already affecting many weather and climate extremes in every region across the globe. Evidence of observed changes in extremes such as heatwaves, heavy precipitation, droughts, and tropical cyclones, and, in particular, their attribution to human influence, has strengthened since AR5.”***



# NOAA Mission: Science – Service - Stewardship

- NOAA climate **Science** is the foundation for smart policy, and decision-making in a changing world.
- NOAA delivers climate **Services** to federal agencies, states, tribes, communities, and businesses across America, helping people protect themselves and their livelihoods in a changing world.
- NOAA's climate **Stewardship** protects our lands, waters, resources, and people.



# NOAA Priorities

*Science, Service and Stewardship*



## Climate

Establish that NOAA is the authoritative source for climate products and services that can be applied to a diverse range of missions.



## Balance

Advance NOAA's complementary work on environmental stewardship and economic development with a particular focus on the New Blue Economy.



## Equity

Exhibit equity in how we build and provide services. Within NOAA, we will promote diversity, equity, inclusion and accessibility in the workforce. Externally, we will provide equitable access to our products and services.

[noaa.gov/our-mission-and-vision](https://noaa.gov/our-mission-and-vision)



# Presidential Executive Orders Provide Direction, Add to Existing Mission Charters



## Executive Order on Tackling the Climate Crisis at Home and Abroad

JANUARY 20, 2021 - PRESIDENTIAL ACTION

The United States and the world face a profound climate crisis. We have a narrow window to pursue action at home and abroad in order to avoid the most catastrophic impacts of that crisis and to seize the opportunity that tackling climate change presents. Domestic action must go hand in hand with United States international leadership, aimed at significantly enhancing global action. Together, we must listen to science and meet the moment.

By the authority vested in me as President by the Constitution and the laws of the United States of America, it is hereby ordered as follows:

### PART I — PUTTING THE CLIMATE CRISIS AT THE CENTER OF UNITED STATES FOREIGN POLICY AND NATIONAL SECURITY

Section 101. Policy. United States international engagement to address climate change — which has become a climate risk — is more necessary and urgent than ever. The scientific community has made clear that the scale and speed of necessary action is greater than previously believed. There is little time left to avoid setting the world on a dangerous, potentially catastrophic, climate trajectory. Responding to the climate crisis will require both significant short-term global reductions in greenhouse gas emissions and net-zero global emissions by mid-century or before.

It is the policy of my Administration that climate considerations shall be an essential element of United States foreign policy and national security. The United States will work with other countries and partners, both bilaterally and multilaterally, to put the world on a sustainable climate pathway. The United States will also move quickly to build resilience, both at home and abroad, against the impacts of climate change that are already manifest and will continue to intensify according to current trajectories.

Sec. 102. Purpose. This order builds on and reaffirms actions my Administration has already taken to place the climate crisis at the forefront of this Nation's foreign policy and national security planning, including submitting the United States instrument of accession to join the Paris Agreement. In implementing — and building upon — the Paris Agreement's three overarching objectives (a safe global temperature, increased climate resilience, and financial flows aligned with a pathway to ward low greenhouse gas emissions and climate-resilient development), the United States will exercise its leadership to promote a significant increase in global climate ambition to meet the climate challenge. In this regard:

## Opportunities for Expanding and Improving CLIMATE INFORMATION AND SERVICES FOR THE PUBLIC



REPORT TO THE NATIONAL CLIMATE TASK FORCE • OCTOBER 2021



# Providing Mission Essential Solutions



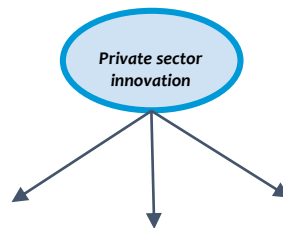
# NOAA's Data & Services

More than 200 water level stations measure water level in real-time, updated every 6 mins (NOS/CO-OPS)

NOAA's NCEI is the long-term **archive** for all NOAA coastal water level data

Using water level data, NOAA scientists (& partners) **developed models** for tide predictions for **up to 2 years** in the future in 3,000+ locations in the U.S.

The NOAA Tide Predictions interface provides tide predictions **daily, weekly, & monthly** in specific locations with advanced capabilities to further customize the predictions generated



NOAA issues a High Tide Flooding Bulletin each season; the NWS issues flood **watches & warnings**

NOAA's official tidal predictions are essential for safe navigation & protection of coastal infrastructure, & are used by state/local govts, emergency managers, shipping industry, offshore wind companies, etc.



## Data collection

## Processing & storage

## Research & modeling

## Product development

## Dissemination

## Application

From the bottom of the ocean to the surface of the sun, NOAA's robust network of **satellites**, weather radars, buoys, ships, aircraft, water level stations, etc. are **observing & collecting data 24/7**

4 National Centers for Environmental Information (NCEI) host the **authoritative archives** of the Nation's **climate and historical weather data & information**

NOAA's 6,000 scientists & engineers at our labs, science centers, modeling centers, & our partners, are **analyzing the data, conducting research**, & producing world-class **predictive models**

Our scientists, in partnership with universities, private sector, other federal agencies, etc., **create products, tools, & educational resources** that integrate historical weather & climate data, observations, & our world-class models predict future conditions

- NWS issues life-saving weather **forecasts & warnings**
- Monthly **climate reports**
- National Climate Assessment with future **predictions & projections** of impacts from climate change
- We provide **maps & other data visualization tools** to understand projected impacts of climate-related events (hurricanes, extreme heat, drought, etc.)

Stakeholders at all levels - private sector, local/state govt, the general public - **utilize our information & tools to make decisions** in both the short-term (weather) and long-term (climate)



## Our aspiration

Provide a truly integrated digital understanding of our earth environment that can evolve quickly to meet changing user expectations by leveraging our own capabilities and partnerships

**NESDIS**  
*Reimagined*

# NESDIS Level Requirements (NLR)

The **Legacy** approach for requirements definition and management:

- Organized around satellite programs and is often **tied to specific instruments and hardware**;
- **Difficult to track** requirements that rely on multiple observations; and
- System optimization very difficult.

Our assessment of trends in Earth Science and satellite Earth Observations show the **growing importance of earth system assessments, integrated or blended** data products, and satellite observations operating as part of the overall observing system to meet NOAA mission objectives.

- We must manage our satellite assets in part by **how they play with other elements** of the system.
- When we architect our contributions to the overall system, we **start by defining the outcome** we want the system to produce, and **then** move to the **specification of the individual** satellite components.

The new NESDIS Level Requirements (NLR) address this need by defining the observing system or mission requirements we must address to meet NOAA objectives.

- The NLR provide a **thematic or mission service area framework** to define mission needs.



# NOAA Is Operating in Partnership with Others

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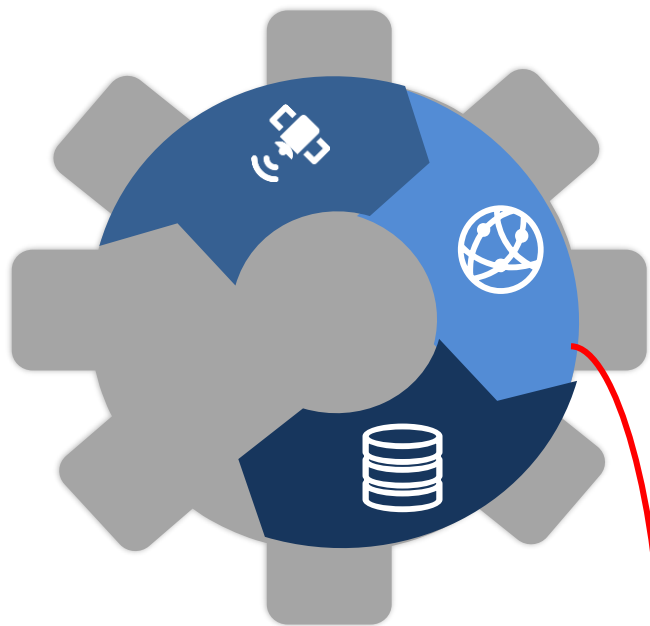
Comm



- USA
- JAPAN
- SOUTH KOREA
- INDIA
- CHINA
- FRANCE
- RUSSIA
- SPAIN
- CANADA
- NOAA
- EUMETSAT
- EUROPEAN COMMISSION
- NATIONAL SPACE ORGANIZATION (NSPO)
- EUROPEAN SPACE AGENCY
- NASA
- DEPARTMENT OF DEFENSE



# NESDIS Leads in Innovative Systems, Product, and Service Delivery; Leverages Partner Satellite Tech and Commercial Distribution



## *Products and Services that are Useful, Usable, and Used*

### Sat Tech Innovation

Instrument & Mission innovation; smallsat constellations; Commodity spacecraft and data services; basic science process research

### Product and Service Innovation

Observing system integration; Global data archives; Operational constellation management; Cloud operations; Artificial Intelligence; Rigorous User Needs Assessment

### Commercial Applications

Apps; Emerging Digital Interface and Distribution; Enhanced & Tailored Products and Services; Cloud platforms

**NESDIS Provides Mission Solutions**

**Partner Engagement**



# NOAA's Next-Gen Earth Observation Strategy

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

### LEO

Miniaturized instruments on small, affordable, and proliferated satellites and partner data improving forecasts through better and additional data. Better precipitation forecasts, wave height predictions, ocean currents, and more.

### GEO

Continuous real-time observations supporting warnings and watches of severe weather and hour-by-hour changes. High inclination orbits to observe northern latitude and polar regions.

### Space Weather

Reliably monitoring space weather from all applicable orbits (e.g., L1, GEO, LEO, HEO, L5) to protect the nation's valuable, critical infrastructure. New capabilities at L5 and high earth orbit provide additional insight and improve forecasts.

### Common Ground Services

Secure ingest and processing 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.



# Geostationary (GEO) Portfolio



# GeoXO User Engagement in 2020-2021

NOAA is going directly into the user community to fully understand their current and evolving needs. We do this through a variety of means, as demonstrated with our 2020-2021 GeoXO User Engagement effort.

## User Needs Virtual Workshops

- Topics of **Fire** (178 attendees), **Weather** (233), **Agriculture** (152), **Health** (207), **Oceans** (142)
- Federal: NASA, USGS, and 20 other federal agencies
- State/Local: 26 States, multiple cities, and several counties and tribal areas
- International: WMO, Canada, Mexico, EUMETSAT, Caribbean/South American orgs
- Industry: more than 70 companies and advocacy groups from weather, transportation, communications, media, aerospace, natural resource and energy sectors
- Academia: more than 60 universities

## Community Meeting on NOAA Satellites

- 1013 participants representing 33 countries
- >250 organizations including Federal Agencies, international meteorological organizations, academia, and industry
- NASA, JAXA, ESA, EUMETSAT, JMA, KARI, Copernicus

## Listening Sessions, Panels, and Presentations

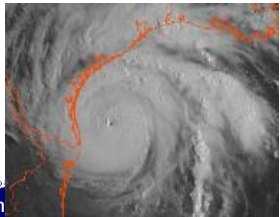
- National Weather Association
- American Meteorological Society
- American Geophysical Union



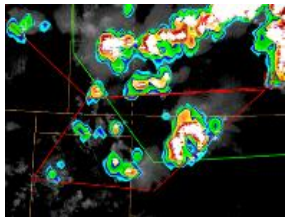
# Continuity & Enhancement of NOAA's Observing System in GEO

- In addition to ensuring continuity of today's 24/7 now-casting, GeoXO advances NOAA's observational capabilities to meet mission requirements and supports World Meteorological Organization's vision for 2040
- GeoXO observations will provide a comprehensive understanding of the atmosphere, oceans, and weather through 2050, including potential new capabilities (depending on budget):
  - **Improved nighttime monitoring of severe weather and hazards** with a Day/Night Imager
  - **Better forecasts with improved numerical weather prediction and nowcasting** with IR Sounder
  - **Reduced health impacts from poor air quality** with Atmospheric Composition Instrument
  - **Enhanced monitoring of ocean health and productivity** with Ocean Color Instrument

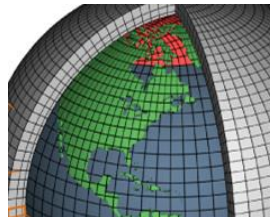
Vis/Near-IR Imagery



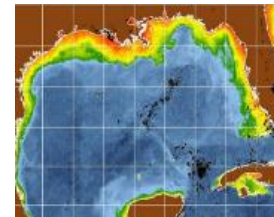
Lightning Mapping



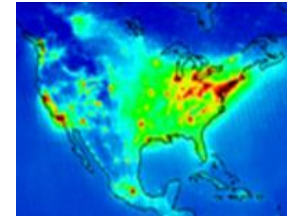
IR Sounding



Ocean Color



Atmo. Composition



# 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



# Low Earth Orbit (LEO) Portfolio



# Highly Diverse LEO Observations

*Foundational Products: Satellite Radiances and Satellite Imagery*

*NESDIS Level Requirements – Geophysical Products*

Atmosphere

Cryosphere

Land

Ocean, Fresh Water & Coasts

*Analytical*

Climate & Weather

Ocean, Fresh Water & Coasts



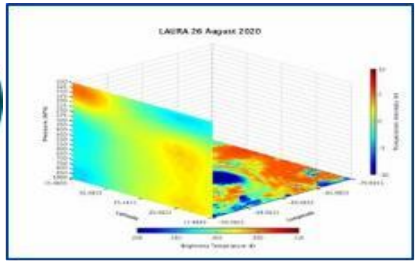
Multipurpose VIS/NIR/IR Imagery



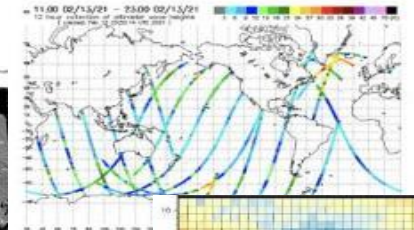
UV Imagery



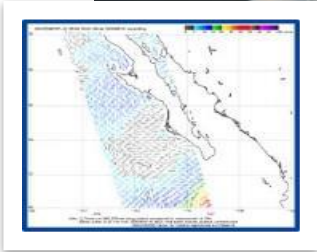
Soundings from IR/MW/RO



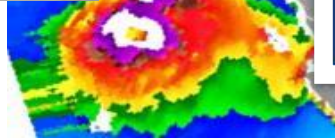
Altimetry



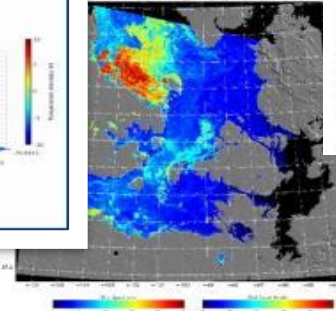
Scatterometry



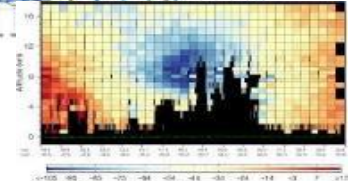
MW Imagery



RADAR Imagery

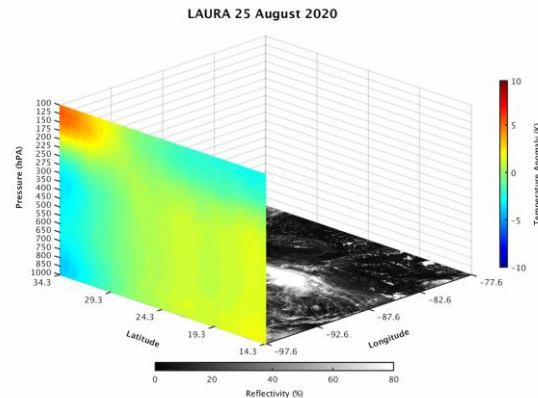


LIDAR



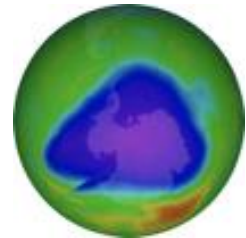
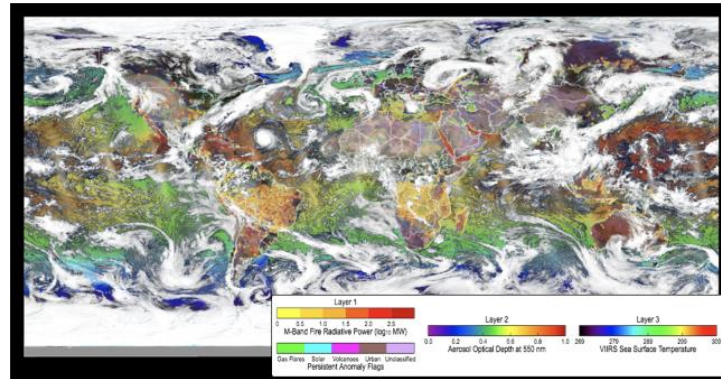
# JPSS Measurements in LEO Are the Backbone of Weather Prediction

**Advanced Technology Microwave Sounder and (ATMS) and the Cross-track Infrared Sounder (CrIS)** are the backbone of Numerical Weather Prediction Models (NWP) for issuing short term as well as 5 day forecasts of severe weather including tropical storms and other types of precipitation.

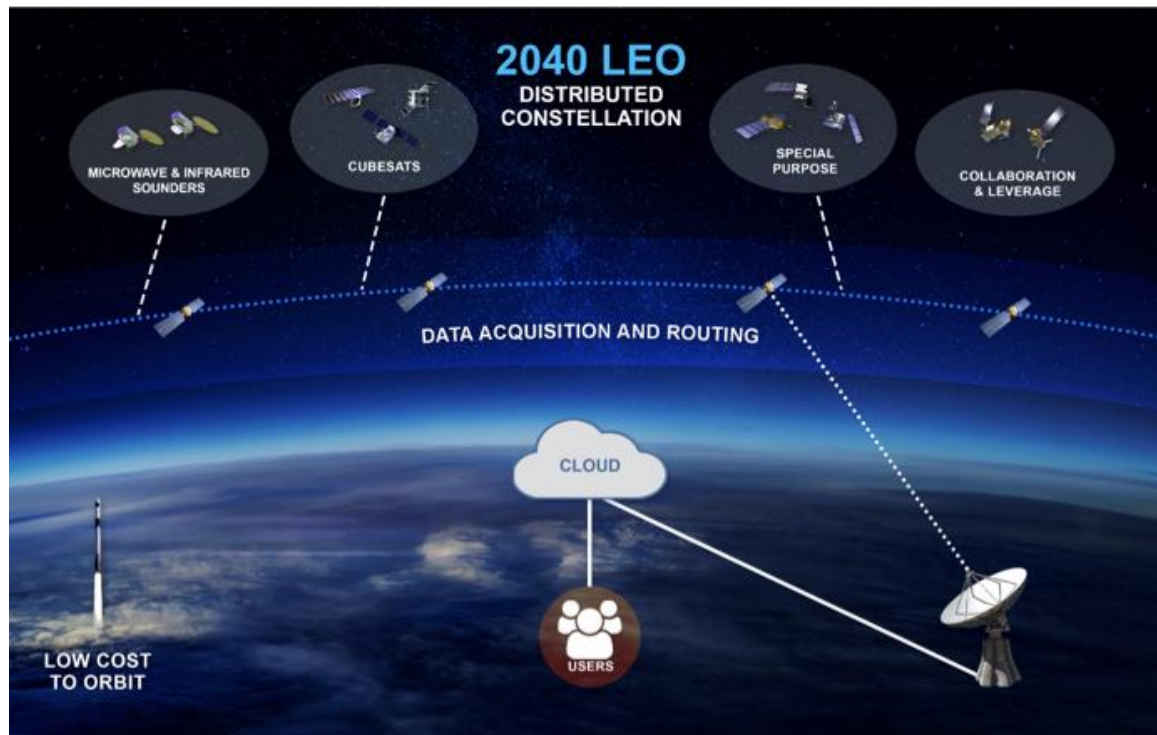


**Ozone Mapping and Profiler Suite (OMPS)** tracks the health of the ozone layer and measures the concentration of ozone in the Earth's atmosphere

**The Visible Infrared Imaging Radiometer Suite (VIIRS)** provides data for critical products such as global imagery, fire detection and intensity, cloud properties, upper atmosphere wind speed, sea surface temperature, ocean color, vegetation health, flood extent, air quality and land cover



# Future LEO: Support Growing Stakeholder Needs via a Disaggregated Architecture



***Evolve the capability to launch advanced sensors when and where needed***



# Space Weather Observations (SWO) Portfolio



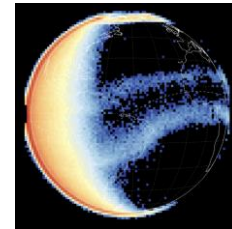
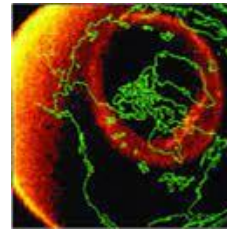
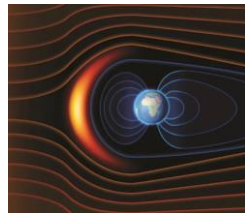
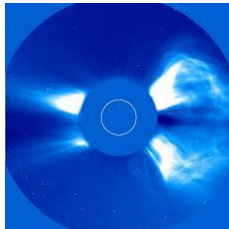
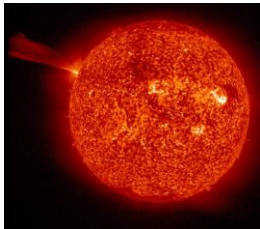
# Space Weather Observation: Mission Needs

**Ongoing Needs:** Users require continuity of existing observation for protecting **critical power grid infrastructure, civil aviation,** and provide **space situational awareness (SSA):**

- **Power grid, aviation, and SSA** require solar wind in situ data, coronal and solar imagery for early warning of damaging space weather events to protect critical national infrastructures.
- **Aviation, space commerce, navigation, and communications** need ionospheric and magnetospheric observations and forecasts for disturbances resulting from solar and geomagnetic activity.

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

- **Longer-lead time and more accurate solar storm warnings** require operational off-Sun-Earth-axis (L5) observations.
- **Aviation, energy, and defense** require forecast the location of the auroral oval and probability.
- **Aviation, space commerce, energy, defense** would use thermosphere imagery and in situ observations for upper atmospheric weather and satellite drag forecasting.



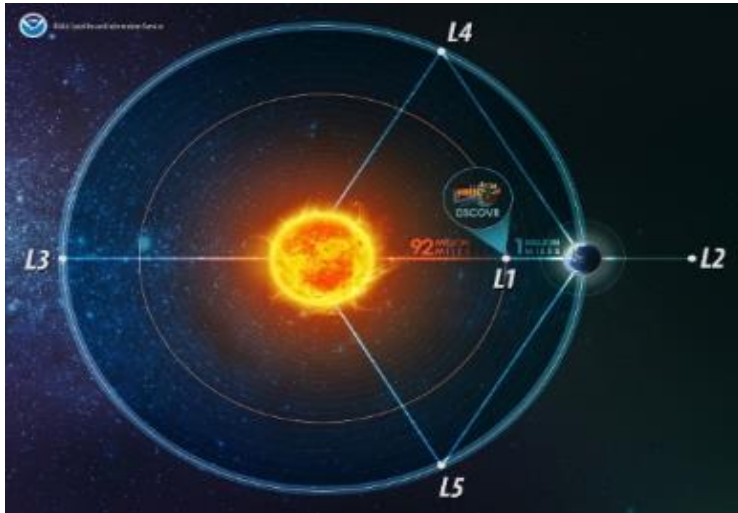
Space Weather-related **economic losses could be “even more than a trillion dollars” just for the power grid**, without accurate forecasts. **FEMA: Space weather sits alongside pandemic** as the only two natural hazards with the potential for **nationwide and global impacts**.

Source: Congressional Budget Office (CBO), 2020: Enhancing the Security of the North American Electric Grid & Federal Emergency Management Agency (FEMA), 2019: 2019 National Threat and Hazard Identification and Risk Assessment



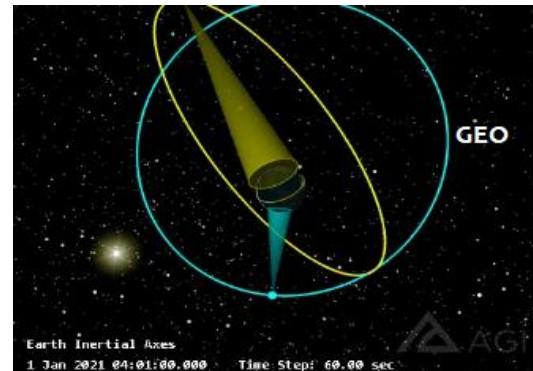
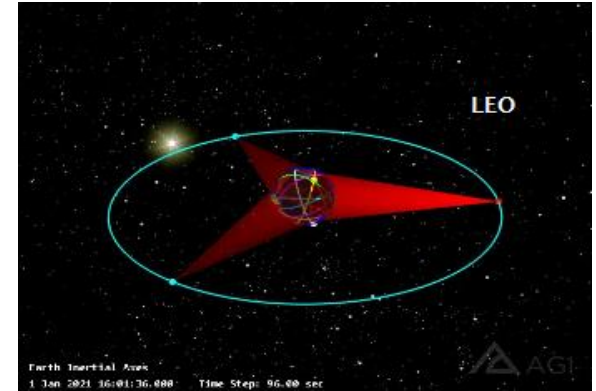
# Space Weather Observations (SWO)

NESDIS SWO will provide comprehensive observational capability from several orbital regimes.



*Solar wind measurements and coronal and solar imagery at L1 and L5.*

*Ionospheric and auroral observations from low earth orbit.*



*Coronal and solar imagery and magnetospheric and particle measurements from geostationary orbit.*



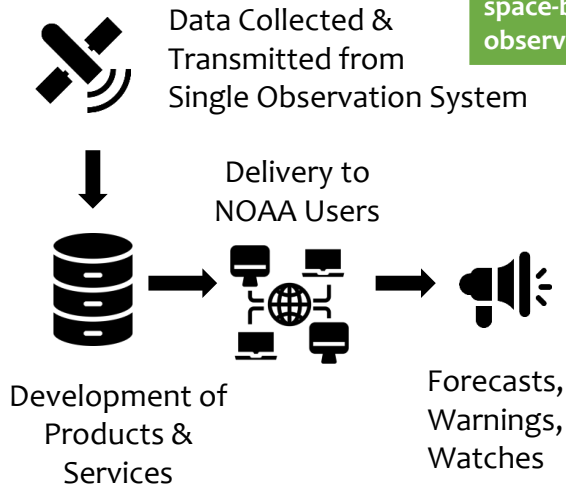
# Common Services & Product Development



# Advancing Data Science and Information Services

## TODAY'S GROUND SERVICE

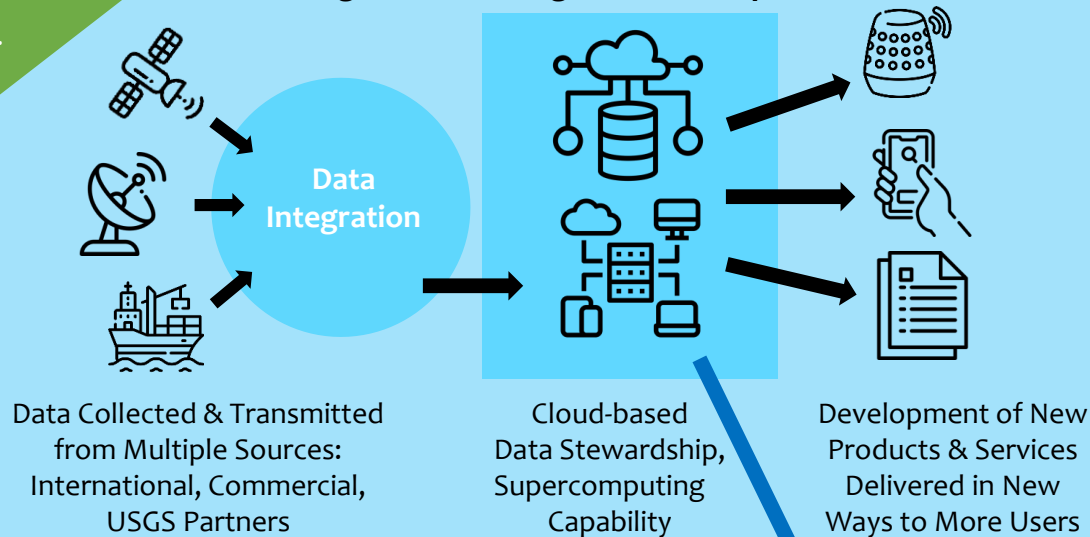
- Single system data services
- Limited computing power



NOAA is moving to a ground system that matches our agile space-based observation systems.

## TOMORROW'S GROUND SERVICE

- Secure ingest for all data types
- Powered by AI, data science
- High performance computing capability, cloud transition & hosting for data storage, stewardship & access



Co-located Earth system data available for Data-Driven Science

# Commercial Weather Data: Open and Operational

## Radio Occultation (RO) Data to Date:

- **Commercial Weather Data Pilot Round 2 Completed Spring 2020:** Demonstrated readiness of commercial sector to provide RO data operationally
- **Commercial Weather Data Purchase:** In November 2020 NOAA awarded its first Indefinite Delivery, Indefinite Quantity (IDIQ) contracts to purchase RO data for use in NOAA's operational weather forecasts.
  - NOAA has issued three delivery Orders under the IDIQ contracts.
  - Delivery Order three has just begun and provides 3000 RO measurements per day
  - NOAA plans to issue a follow-on IDIQ in FY2023
- **Continuing Commercial Weather Data Pilots:** NOAA is investigating additional commercial capabilities beyond RO. NOAA plans to issue a Request for Information for commercial Space Weather data this quarter and a broader RFI for a commercial weather data pilot summer of 2022.



**SPACE**NEWS

Learn more  
about NAVJ-10

NAVJ-10

Two companies win first NOAA commercial weather contracts

by JWP Powell — September 10, 2019



GeoOptics and Spire Global will sell weather data collected by small satellites to NOAA under a pilot program that could lead to greater uses of commercial data. Credit: Spire



# Continuity of Observations



Today

GOES-16, -17  
POES (through 2027)  
S-NPP  
NOAA-15, -18, -19, -20  
Jason-3 (through 2024)  
COSMIC-2 (through 2024)  
DSCOVR (through 2025)

Metosat-10    ACE  
Commercial ROCryosat-2  
Himawari-8    GCOM-C, -W  
AQUA    Landsat-8, -9  
DMSP    SOHO  
GOES-10    SEOSAR/Paz  
SMOS  
Sentinel-1B, -2A/2B, -3A/3B, -6MF



2022 - 2025

GOES-T (starting 2022)  
GOES-U (starting 2024)  
JPSS-2 (starting 2023)  
SWFO-L1 (starting 2024)

OceanSat-3 (starting 2022)  
Commercial RO  
Himawari-9 (starting 2022)  
ALOS-4 (starting 2022)  
SWOT (starting 2022)  
NISAR (starting 2022)  
PACE (starting 2023)  
Metop-SG (starting 2024)  
MTG-1 (starting 2023)  
Sentinel-1C, 1D, 2C, 2D,  
3B, 3C, 3D, 6B  
SMAP (through 2025)

GOSAT-GW



2026 - 2030

JPSS-3 (starting 2028)  
COSMIC-3  
SW-Next - L1 (starting 2028)  
SW-Next - L5 (starting 2027)

Commercial RO  
Himawari-10  
GOCI  
Acoustic  
ECS  
Sentinel-6B  
ACCD  
3D Winds  
Tundra  
Citizen Science



2030+

JPSS-4 (starting 2032)  
GeoXO Imager (starting 2032)  
GeoXO Sounder (starting 2035)  
LEO Next Missions (starting 2030)

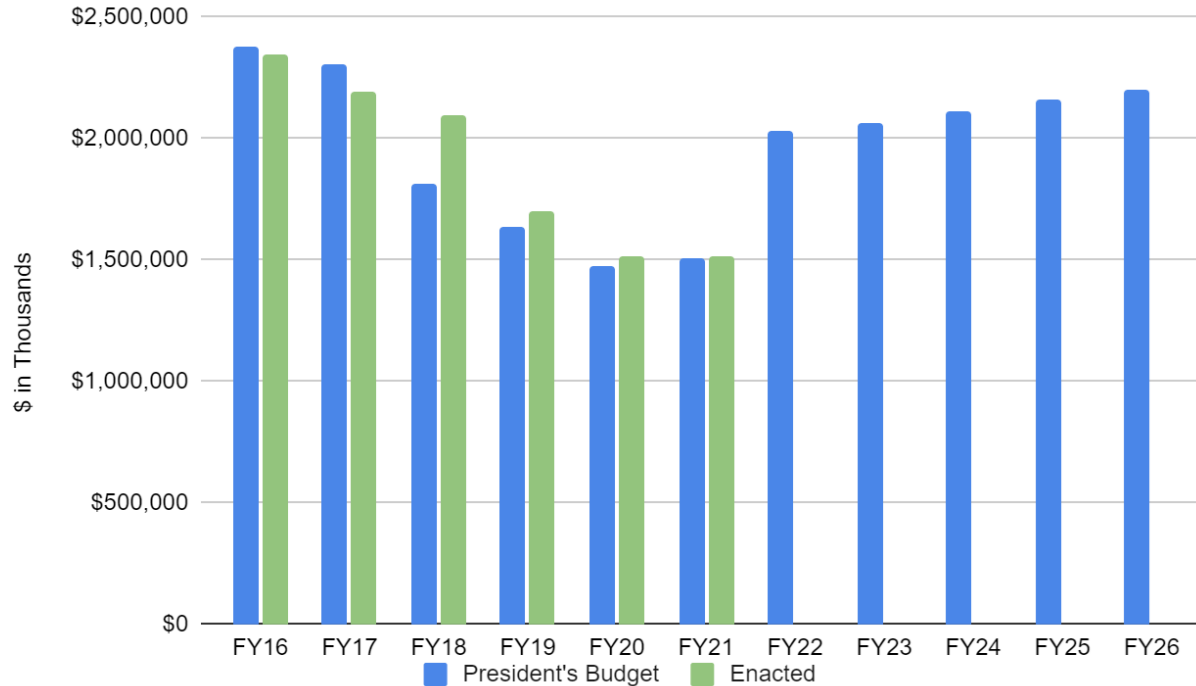
**NOAA  
Satellite  
Data Sources**

**Available &  
Potential Non-  
NOAA  
Satellite Data  
Sources for  
NOAA mission  
needs**



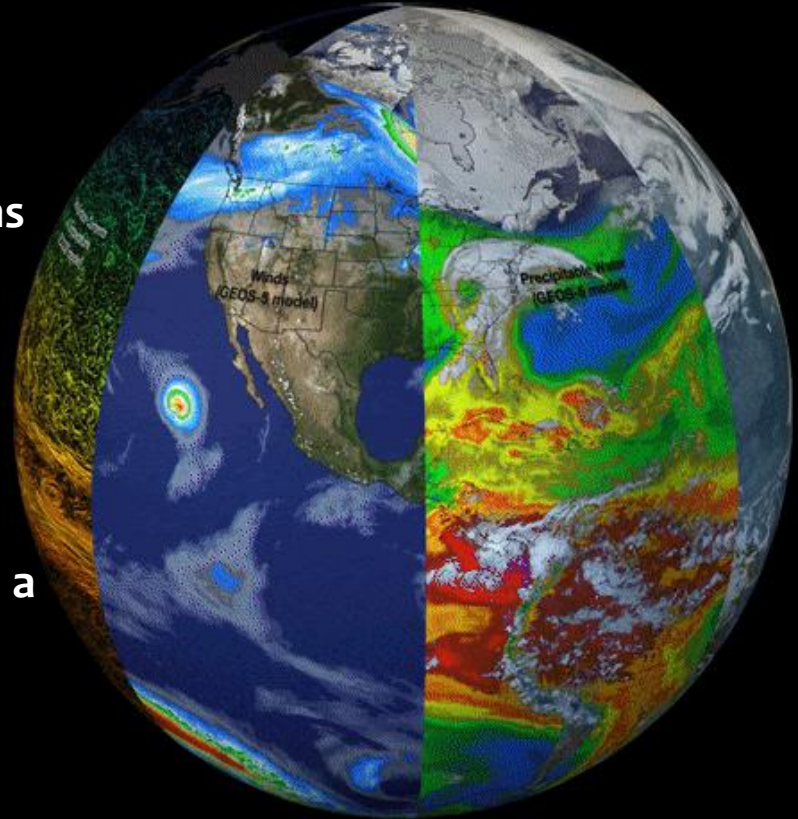
# FY 2016 - FY 2026 Budget

NESDIS's President's Budget & Enacted Budget: 2016 - 2026



# NOAA Creating a “Climate Ready Nation”

- Engaging our users to better understand and meet their needs
- Working with partners to exploit new and emerging technologies in new observing systems and refreshing Information Technology
- Maintaining and growing commercial and international partnerships to deliver a resilient and high-performing observing system
- Meeting the increasing demand for environmental information and data products in a rapidly changing world





# Thank you!

National Environmental Satellite,  
Data, and Information Service

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28 October 2021

**Irene Parker**

NOAA NESDIS Acting Deputy Assistant Administrator for  
Systems, Assistant Chief Information Officer