NOAA UPDATE and STRATEGIC DIRECTION

Joint Spring Meeting of the ASEB and the SSB 2021

Stephen Volz, Ph.D., Assistant Administrator

National Environmental Satellite, Data, and Information Service

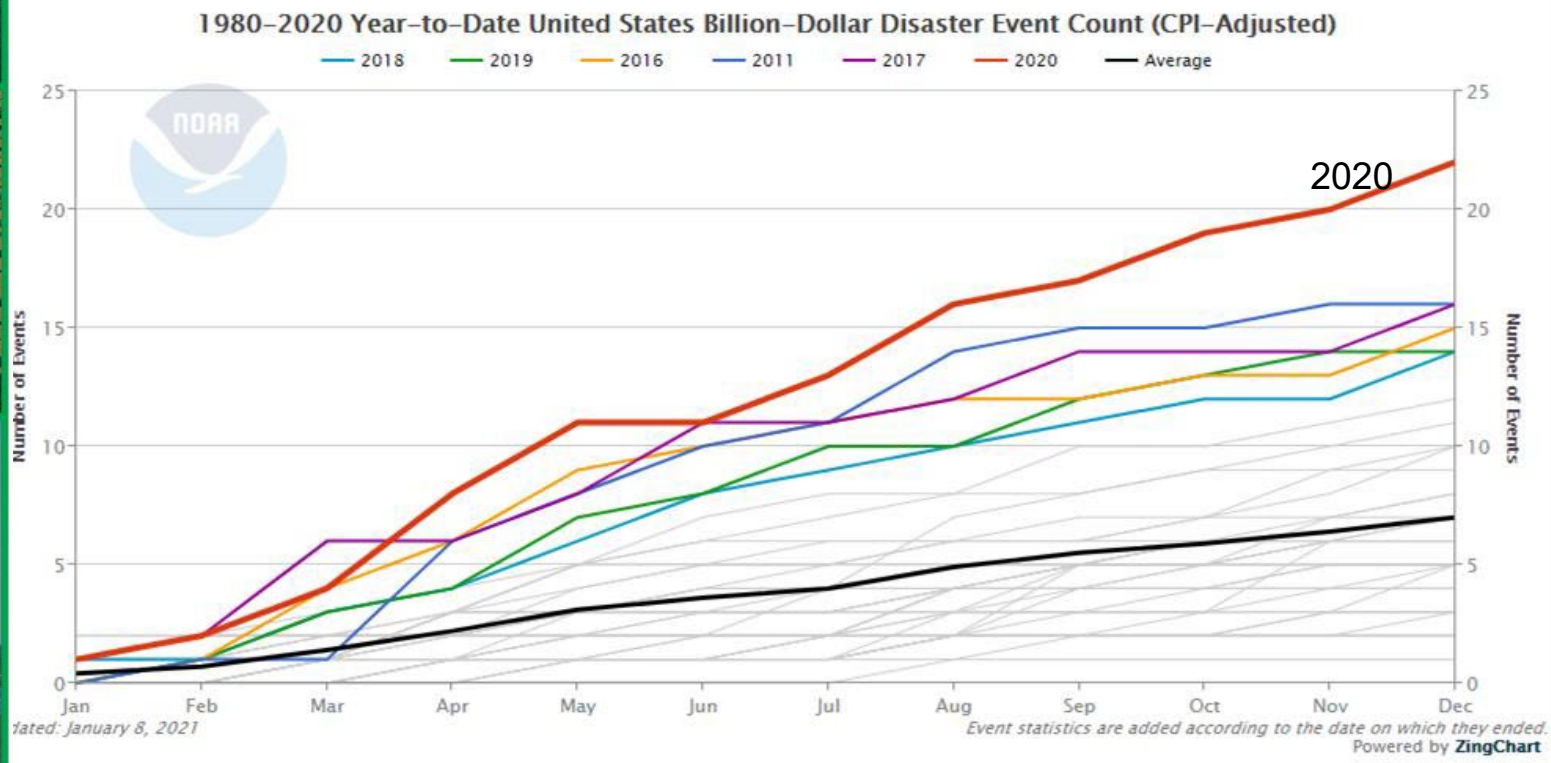
May 27, 2021

Agenda

- Why Now Matters
- Global Satellite Earth Observation Environment
- Four Pillars of NESDIS
- Scoping the Resources Required

Why Now: More Storms, More Severity

NOAA'S Earth observations support weather forecasts valued at $315 billion to the nation's economy, protecting and improving weather-vulnerable industries such as farming, shipping, and utilities.

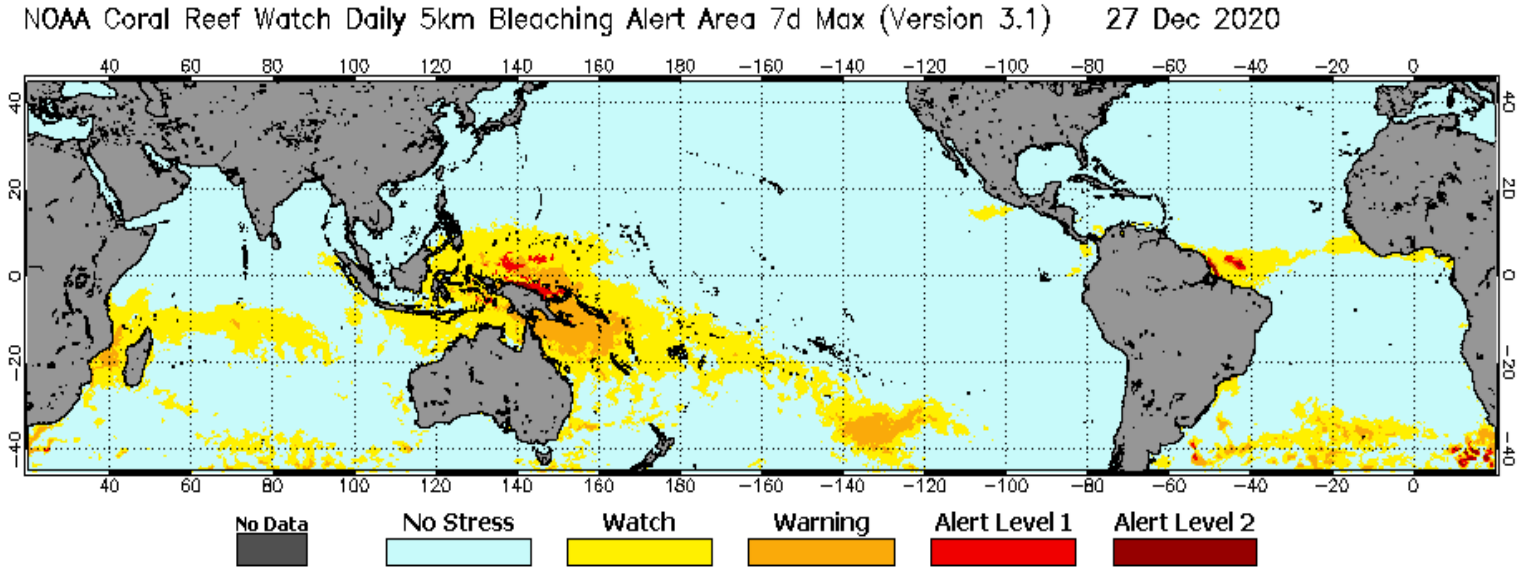


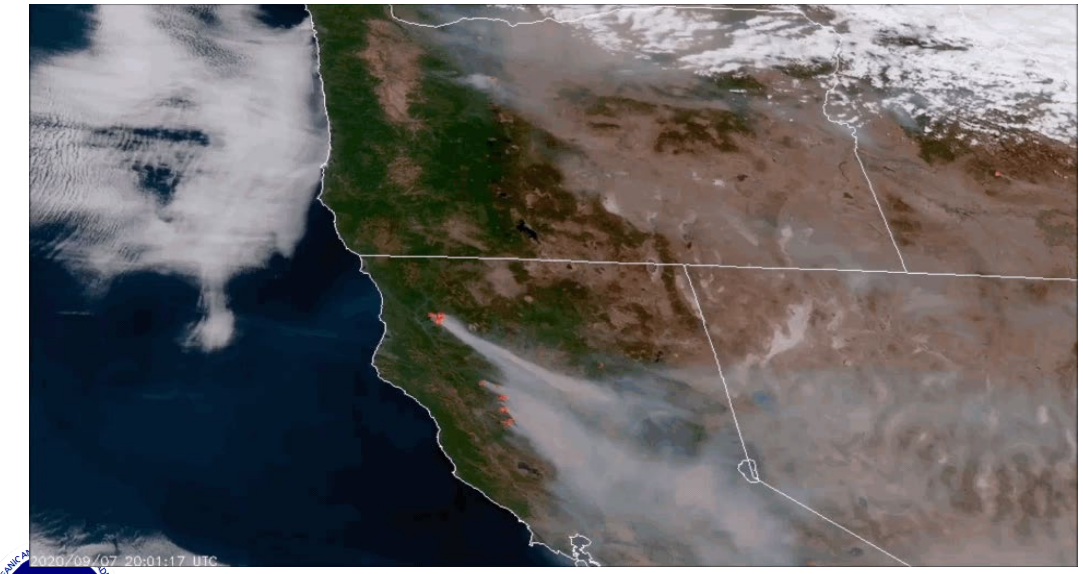
Crisis Response and Economic Recovery

Top: *Coral Reef Watch bleaching alert, December 2020 - January 2021*

Bottom left: *Oregon and California Fires, Sept. 7-9, 2020*

Bottom right: *Fog at San Francisco International Airport, March 2017*





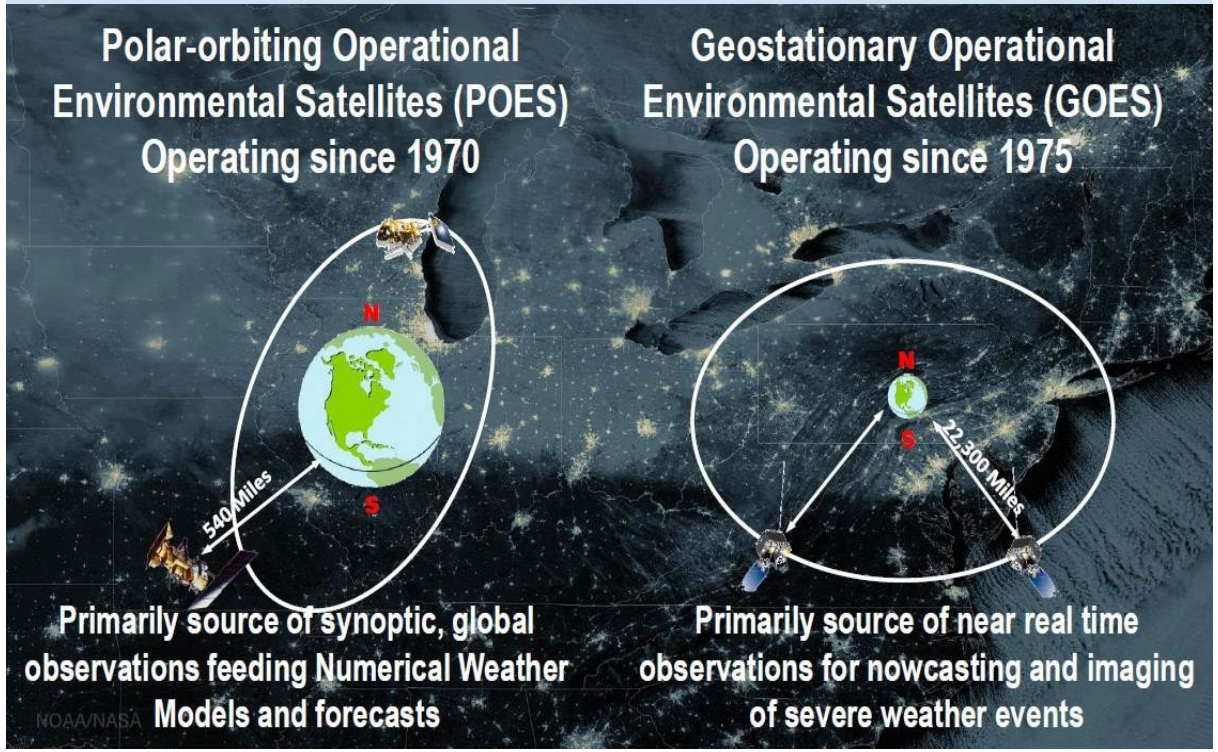
Our aspiration

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

NEEDS & OPPORTUNITIES: NOAA's Evolution away from "Two Orbits, One Mission"

Old Paradigm of "Two Orbits, One Mission"
Originated in 1970's, continued through 2016



Demand and Opportunity Shaping an Earth Observation Architecture for 2030-2050 Epoch:

Intensifying demand for **timelier and more accurate extreme weather predictions**, delivered in faster, user-friendly ways as climate changes.

Increasing value in environmental assessments and projections to inform long-term **land-use, infrastructure and commercial** investments.

Rapid rise in **launch & remote-sensing capability** of U.S. aerospace industry and strategic partners.

Accelerating **innovation in ground systems**: AI, quantum computing, data science, modeling.

NESDIS Programs of Record

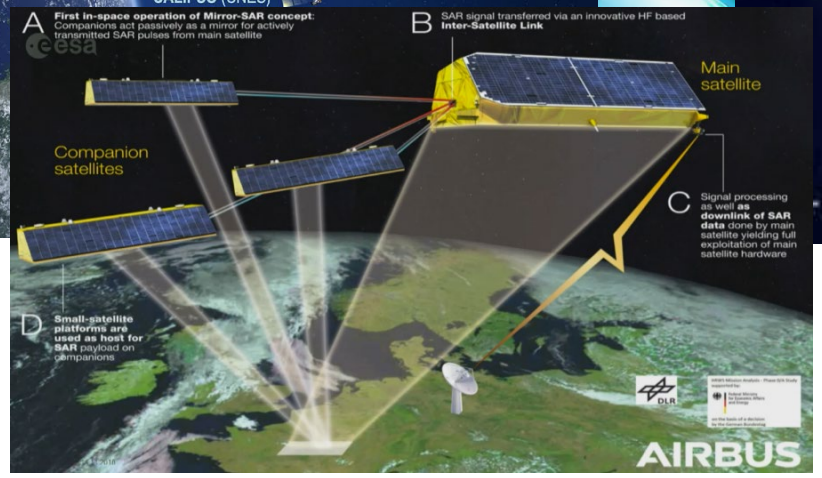
We Are In a Golden Age of Earth Observations

Operational

Plus EUMETSAT, JMA, Copernicus, and our WMO partners

Research

Commercial



NOAA's Next-Gen Earth Observation Strategy

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

LEO

Miniaturized instruments on small, lower cost, 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 & polar regions.

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.

Geostationary – GEO – Portfolio

Broaden Your Perspective

9 Feb 2020: Himawari-8, GOES-17, GOES-16, Meteosat-11 (CIMSS/SSEC)

GEO-XO 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 GEO-XO 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

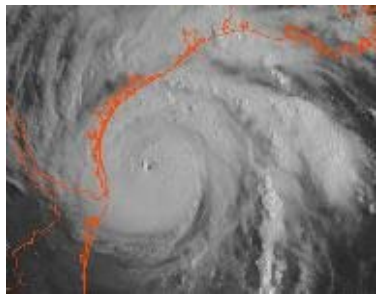
Listening Sessions, Panels, and Presentations

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

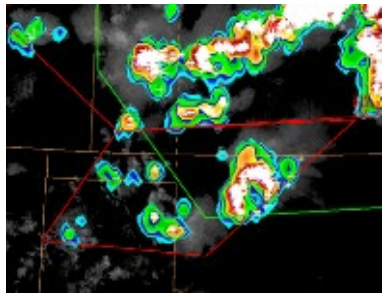
Continuity & Enhancement of NOAA's Observing System in GEO

- In addition to ensuring continuity of today's 24/7 now-casting, GEO-XO advances NOAA's observational capabilities to meet mission requirements and supports World Meteorological Organization's vision for 2040
- GEO-XO 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

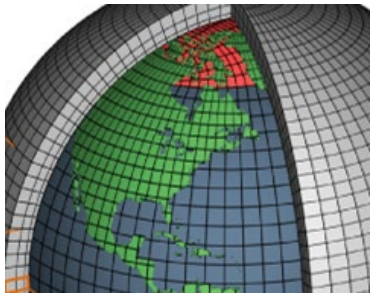
Vis/Near-IR Imagery



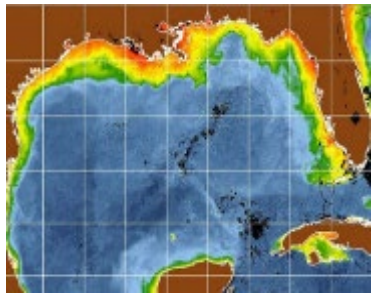
Lightning Mapping



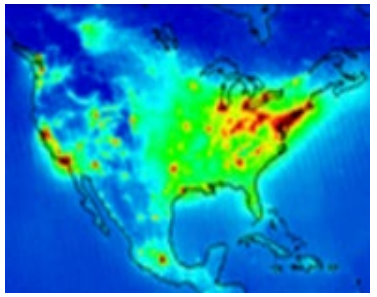
IR Sounding



Ocean Color



Atmo. Composition



Proposed Next-Generation GEO Instruments

Observation/ Instrument	NOAA's Pre-Phase A Instrument Trade Studies	Precursor or Research Instruments Preceding GeoXO	Anticipated Development Timeline
Vis/Near-IR Imager	• Inclusion of Day-Night Band (DNB) • Spectral and spatial upgrades relative to GOES-R • Data compression options	• Advanced Baseline Imager (ABI) on GOES-R	6 years (FY23-29)
Lightning Mapper	• Spatial resolution and frame rate options • Data Compression Schemes • Evaluate on-board jitter detection/correction • Algorithm schemes to process data from multiple telescopes and include star viewing to improve INR	• LIS on NASA TRMM • Lightning Mapper on GOES-R	4 years (FY24-28)
Ocean Color	• Discrete spectral channels vs hyperspectral design • Coverage area and revisit time options • Data Compression Schemes • Instrument commandability and operational timelines	• NASA GLIMR Earth Venture instrument (launch ~2026)	4 years (FY24-28)
Hyperspectral IR Sounder	• Spectral, and temporal resolution options • Inclusion of DNB • Method for meeting data rate requirements • Scan commandability and operational timelines	• In LEO: CrIS on NOAA JPSS and IASI on EUMETSAT Metop • In GEO: GIIRS on FY-4A and IRS on EUMETSAT MTG-S	6 years (FY23-29)
Atmospheric Composition	• Cost, optical design, and test campaign impacts of various levels of polarization performance • Evaluate trade between temporal repeat/field of regard and system cost/design meeting required SNR and spectral sampling & resolution • Polarization study	• NASA TEMPO Earth Venture Instrument and KARI GEMS on GEO-KOMPSAT-2	4 years (FY24-28)

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

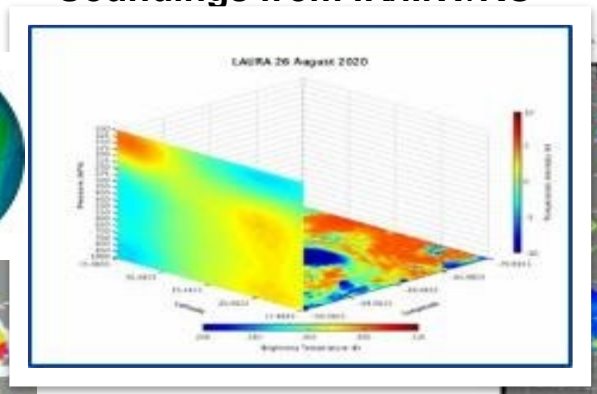
Climate & Weather

Ocean, Fresh Water & Coasts

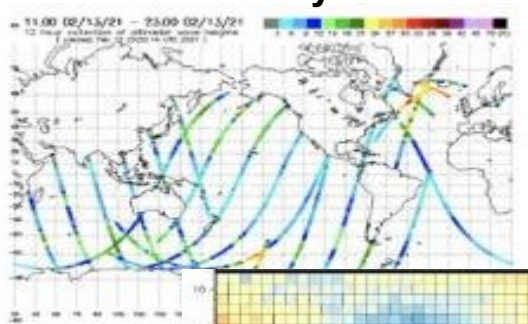
Multipurpose VIS/NIR/IR Imagery

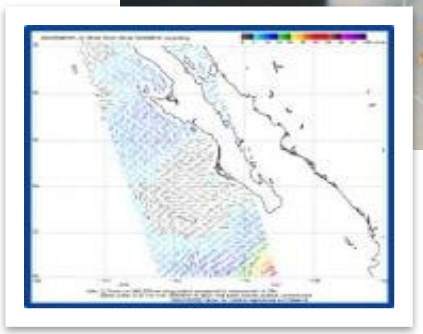
UV Imagery

Soundings from IR/MW/RO

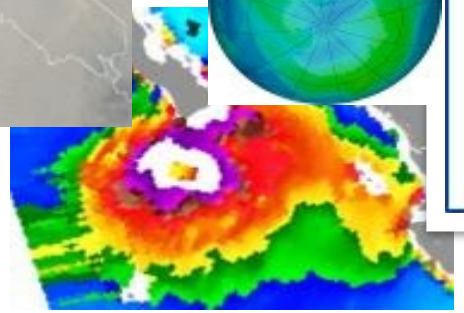


Altimetry

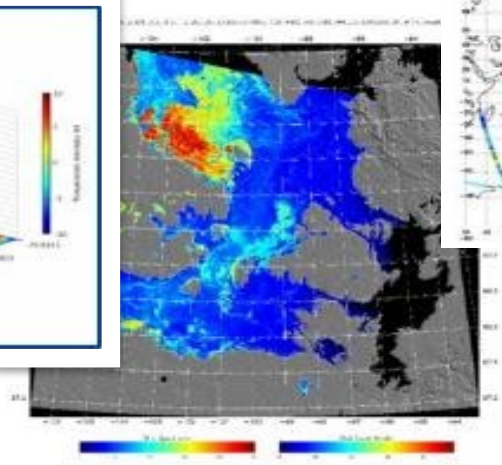




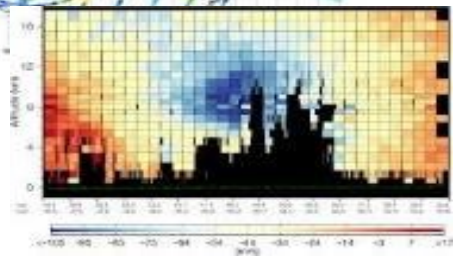
Scatterometry



MW Imagery



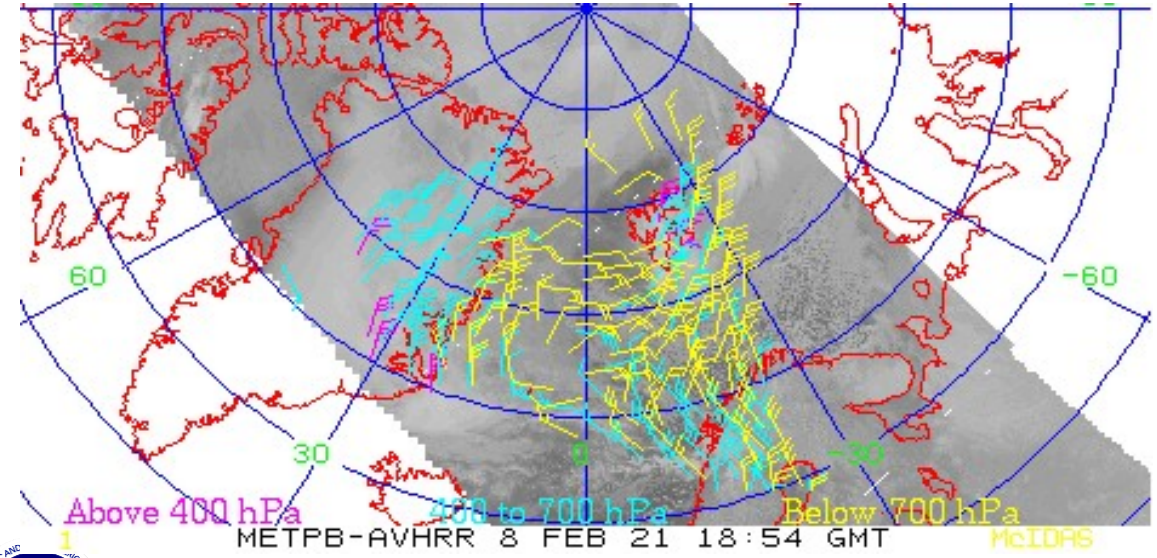
RADAR Imagery

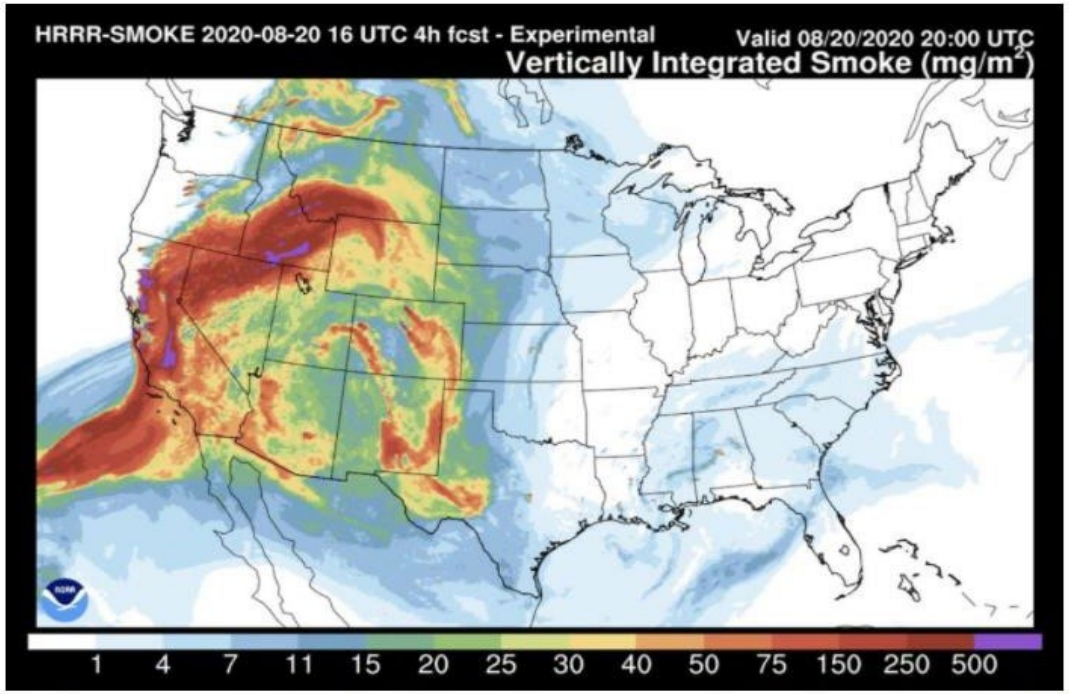


LIDAR

NESDIS LEO Approach: Mission Concepts to Augment Global Measurement Capability

- Launch satellites more frequently to **enhance refresh and augment global observations collected from earth observation satellites,** beginning in mid-2020s
- Replenish **critical sounding data**
- NESDIS completed its LEO SounderSat Milestone-0 Review March 10, 2021





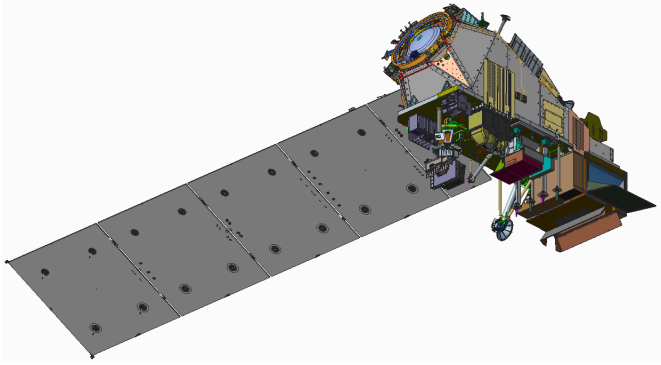
Vertically integrated smoke plot showing HRRR-Smoke forecast on August 20, 2020 valid at 20:00 UTC. The High Resolution Rapid Refresh Smoke model uses a suite of fire products from JPSS satellites.

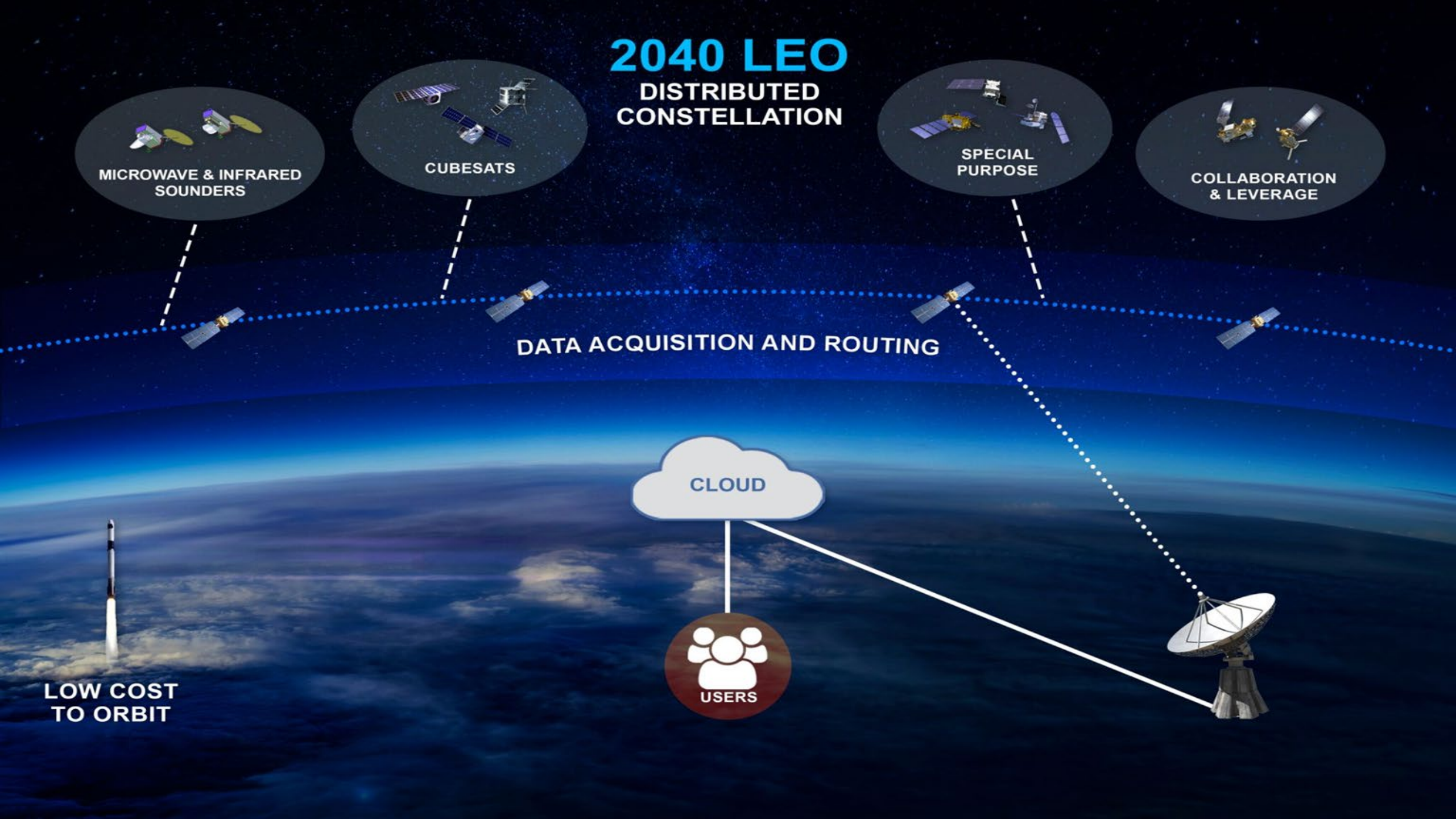
- Capture **3D winds, ocean surface vector winds, precipitation data**, and **low-light imagery**
- **Hybrid approach**: data from NOAA satellites, strategic partners, and commercial providers

Near Term Focus in LEO is on Innovation

In FY 2022, LEO will:

- Complete a Commercial Ground Services Demonstration (JPSS)
- Continue the detailed concept development of the SounderSat Project and the LEO program, including:
  - Milestone 1 for the LEO Program
  - The Mission Concept Review for the SounderSat project
  - The Mission Concept Review for the LEO program



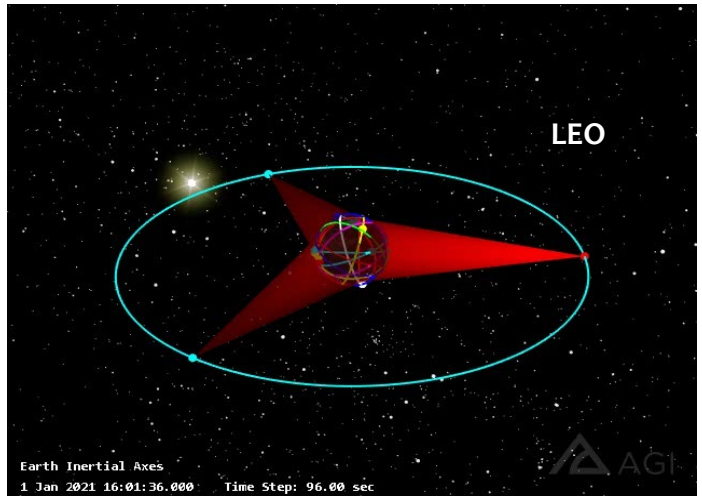

2040 LEO
DISTRIBUTED CONSTELLATION
MICROWAVE & INFRARED SOUNDERS
CUBESATS
SPECIAL PURPOSE
COLLABORATION & LEVERAGE
DATA ACQUISITION AND ROUTING
CLOUD
USERS
LOW COST TO ORBIT

Space Weather – SWO – Portfolio

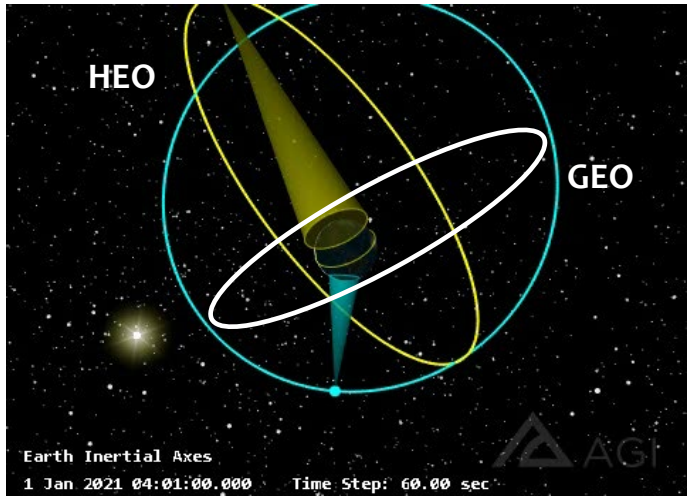
Space Weather Observations Program

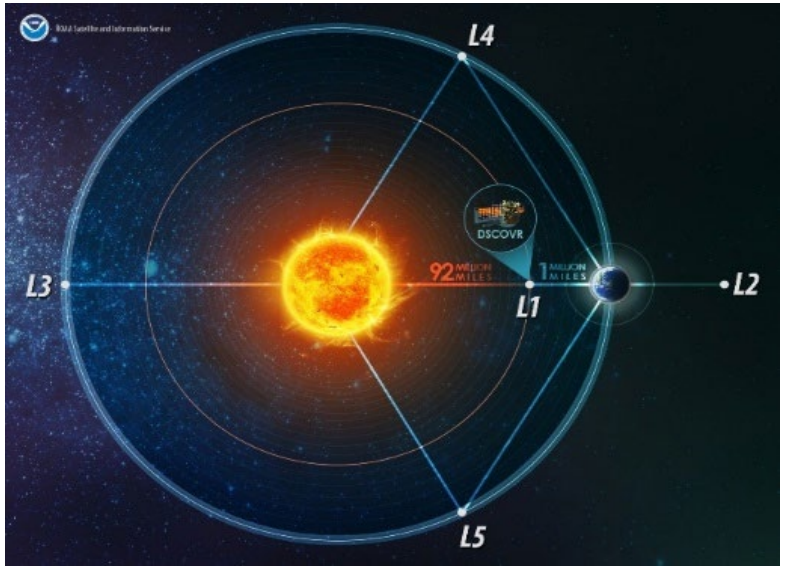
The Space Weather Program will need a comprehensive observational capability for several orbital regimes.

Thermospheric and ionospheric objectives will require in situ measurements from LEO as well as imaging capabilities from GEO.



For the magnetosphere, in situ measurements from GEO and HEO can combined with auroral imaging.





Coronal and photospheric imagery from L1 and L5 can be used for stereoscopic analysis. In situ plasma/field data will drive heliospheric models.

Space Weather Measurements

NOAA measures space weather from NOAA and partner-agency satellites at LEO, GEO, and Lagrange-1 orbits.

Representative missions:

- GOES-R for solar EUV and X-ray irradiance and coronal imagery
- DSCOVR, ACE, and SWFO-L1 for solar wind and interplanetary magnetic field
- GOES-R for magnetospheric particles and magnetic field
- COSMIC-2 for ionospheric electron density and particle flux

Region	Alerts and Warnings	Forecasts
Solar	EUV and X-ray irradiance (1 min)	Photospheric and coronal imagery; magnetic field (GEO or L1; 1-3 days). Sunspot number (months-years)
Heliosphere	Solar wind and magnetic field (L1; 15 min) Solar energetic particles (5 min)	Solar wind and magnetic field (L1; 27 days)
Magnetosphere	Energetic particles; magnetic field (GEO; 1 hour)	Energetic particles (GEO; 2 days)
Ionosphere	Electron density (LEO; 1 min) Particle flux (MetOp; 1 min)	TBD

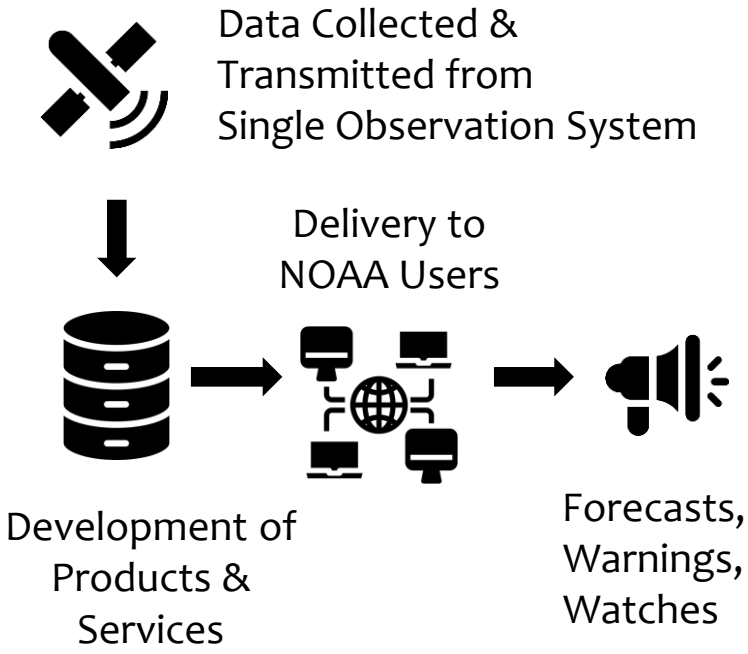
Representative current measurements from the Program of Record 2025. Objectives are identified using mainly SPRWG terminology.

Common Services & Product Development

Advancing Data Science and Information Services

TODAY'S GROUND SERVICE

- **Single system data services**
- **Limited computing power**



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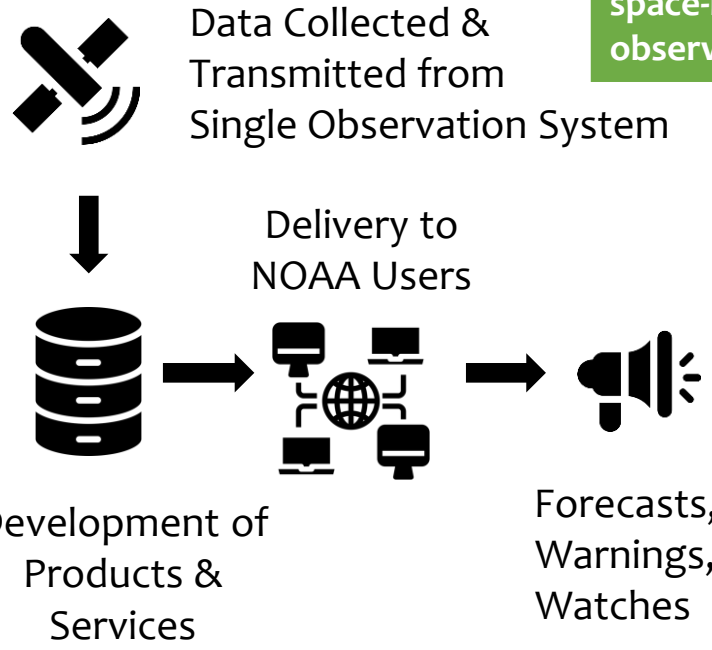
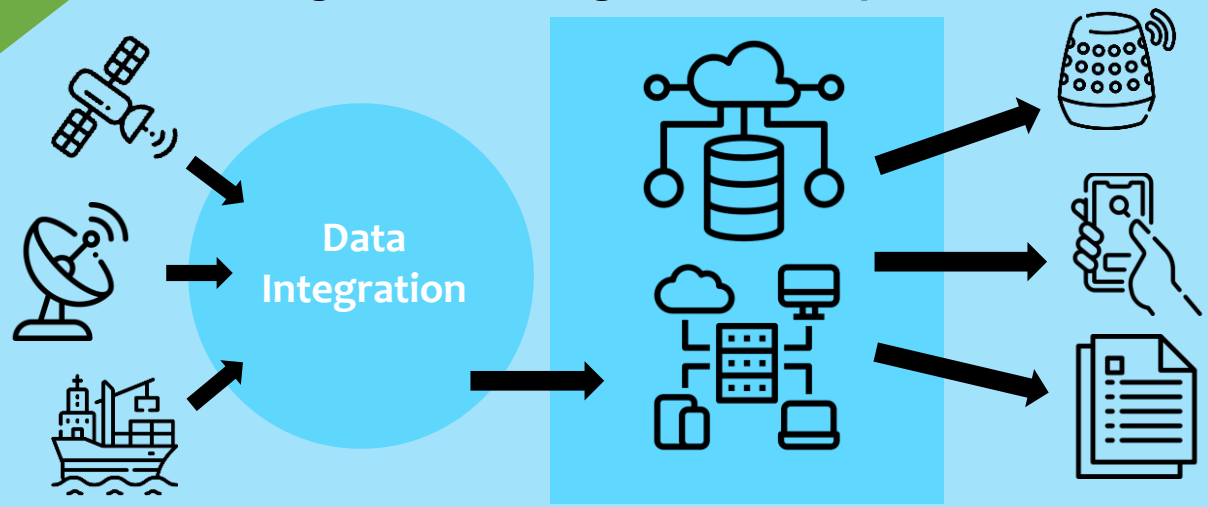


NOAA is moving to a ground system that matches our agile space-based observation systems.

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**



Advancing Data Science and Information Services

TODAY'S GROUND SERVICE

- **Single system data services**
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Data Collected & Transmitted from Single Observation System

Delivery to NOAA Users

Development of Products & Services

Forecasts, Warnings, Watches

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

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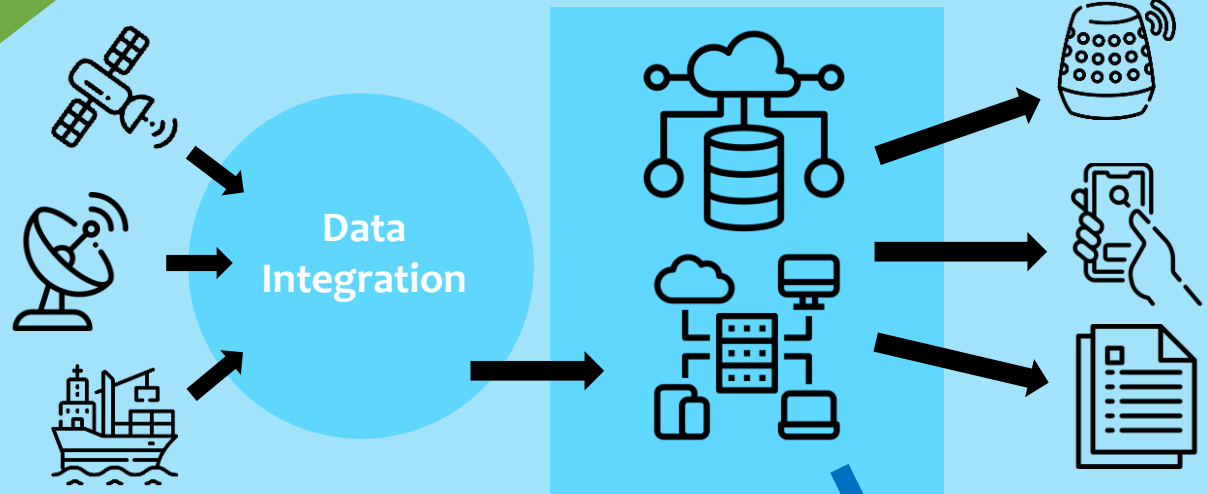


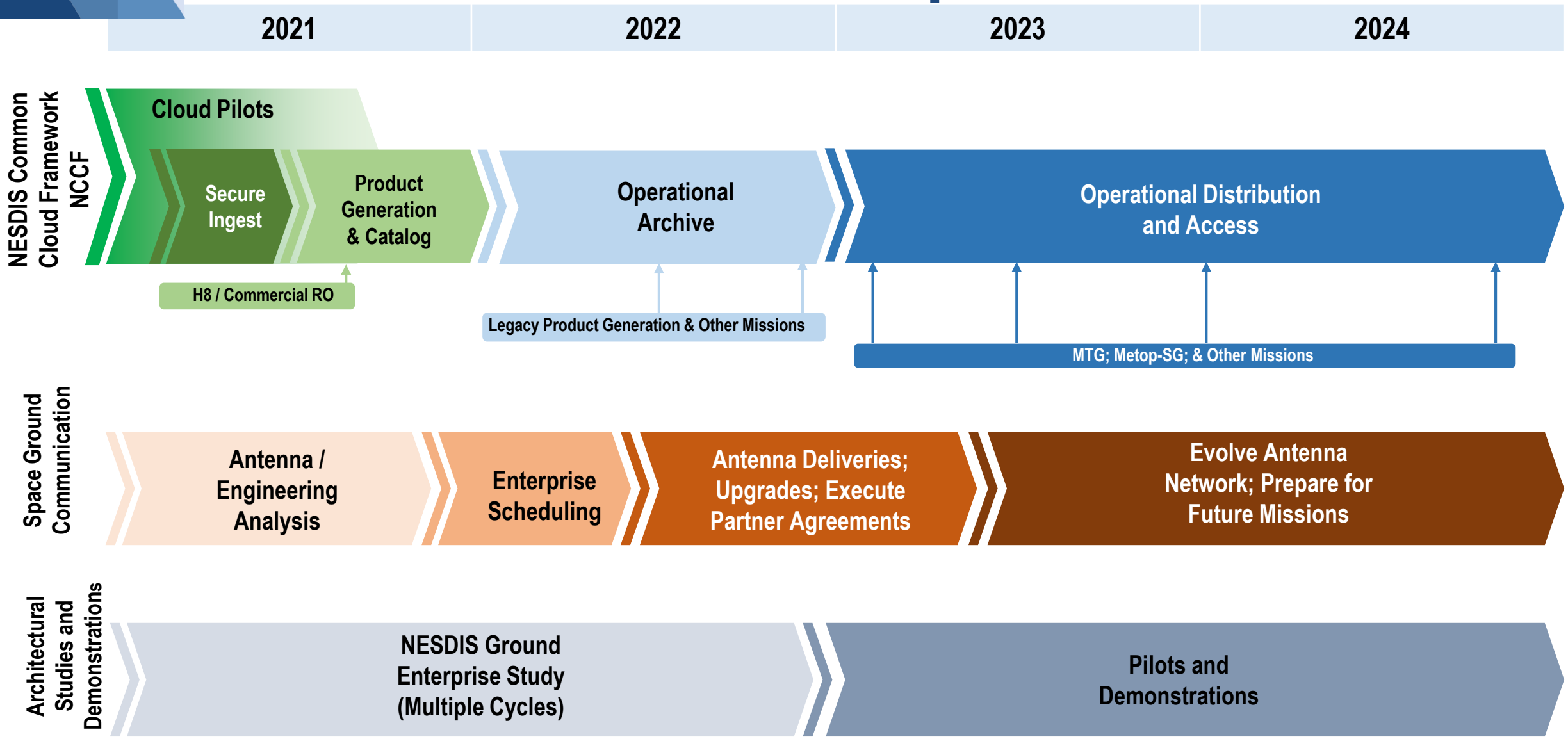
Data Collected & Transmitted from Multiple Sources: International, Commercial, USGS Partners

Cloud-based Data Stewardship, Supercomputing Capability

Development of New Products & Services Delivered in New Ways to More Users

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

Roadmap


2021
2022
2023
2024
NESDIS Common Cloud Framework NCCF
Cloud Pilots
Secure Ingest
Product Generation & Catalog
Operational Archive
Operational Distribution and Access
H8 / Commercial RO
Legacy Product Generation & Other Missions
MTG; Metop-SG; & Other Missions
Space Ground Communication
Antenna / Engineering Analysis
Enterprise Scheduling
Antenna Deliveries; Upgrades; Execute Partner Agreements
Evolve Antenna Network; Prepare for Future Missions
Architectural Studies and Demonstrations
NESDIS Ground Enterprise Study (Multiple Cycles)
Pilots and Demonstrations

Utilizing the Global Integrated Observing System: Now and Future

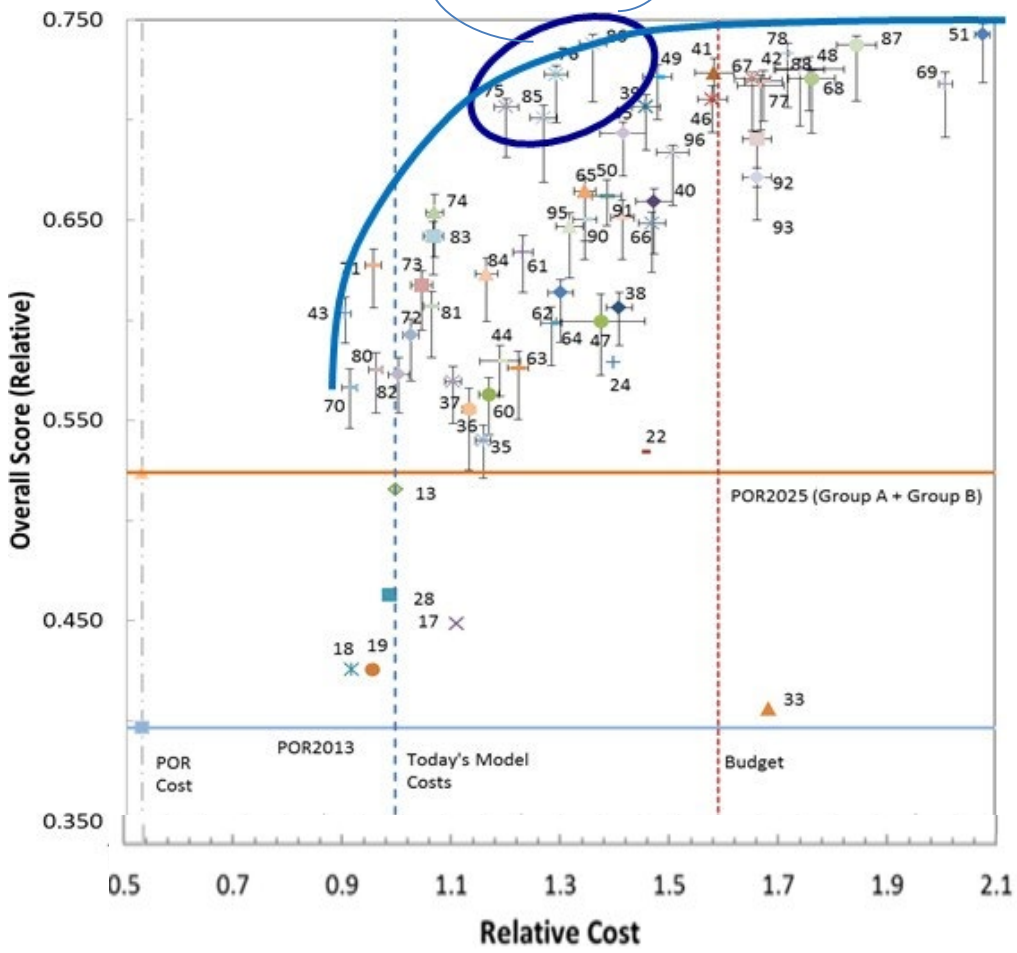
	2020		2025		2030	
Observations	GOES-16, -17 GOES-NOP SNPP, NOAA-20 POES DMSP COSMIC-2 Metop-A/B/C Meteosat-10	Himawari-8 Acoustic ECS Jason-3 DSCOVR ACE SOHO Sentinel-1/3	GOES-17, -18 NOAA-20, -21 COSMIC-2 Metop-SG MTG-I, -S GOES-IO SWFO-L1 Sounder µsats Commercial RO	Himawari-9 GOCI-II Acoustic ECS Sentinel-1/3/6 PACE NISAR SWOT TEMPO, GEMS USV, UAS	GOES-18, -19 PWS COSMIC-3? GLIMR Metop-SG MTG-I, -S GOES-IO SpWx-new SpWx-L5 Sounder µsats Commercial RO	Geo Hyper Himawari-10 GOCI-II Acoustic ECS Sentinel-1/3/6/x ACCD 3D Winds Tundra Citizen Science USV, UAS
Ground Systems	Harris Raytheon Legacy OSPO CLASS	Cloud Pilots	**Integrated OSPO +** Cloud dissemination Cloud processing CLASS in the Cloud		**Integrated OSPO/Cloud +** Sat-Sat communication 3rd party Command & Control	
Products & Services	Weather, Climate, Severe Events (W/C/SE)		**W/C/SE +** Water quality Ocean HAB Climate	Genomics Coastal zone	**All Previous +** CO_2/CH_4 Monitoring Air Quality Ecosystem Forecasting	

Budget & Implementation

NSOSA and Scoping the Future Mission Capabilities and Resource Requirements

These systems can provide our whole earth integrated observing & information system.

The Systems we are planning in this space include enhanced Geostationary, additional Space Weather, disaggregated LEO, utilization of numerous additional research and partner data, and whole earth system data access and interoperability



Programmatic Attributes

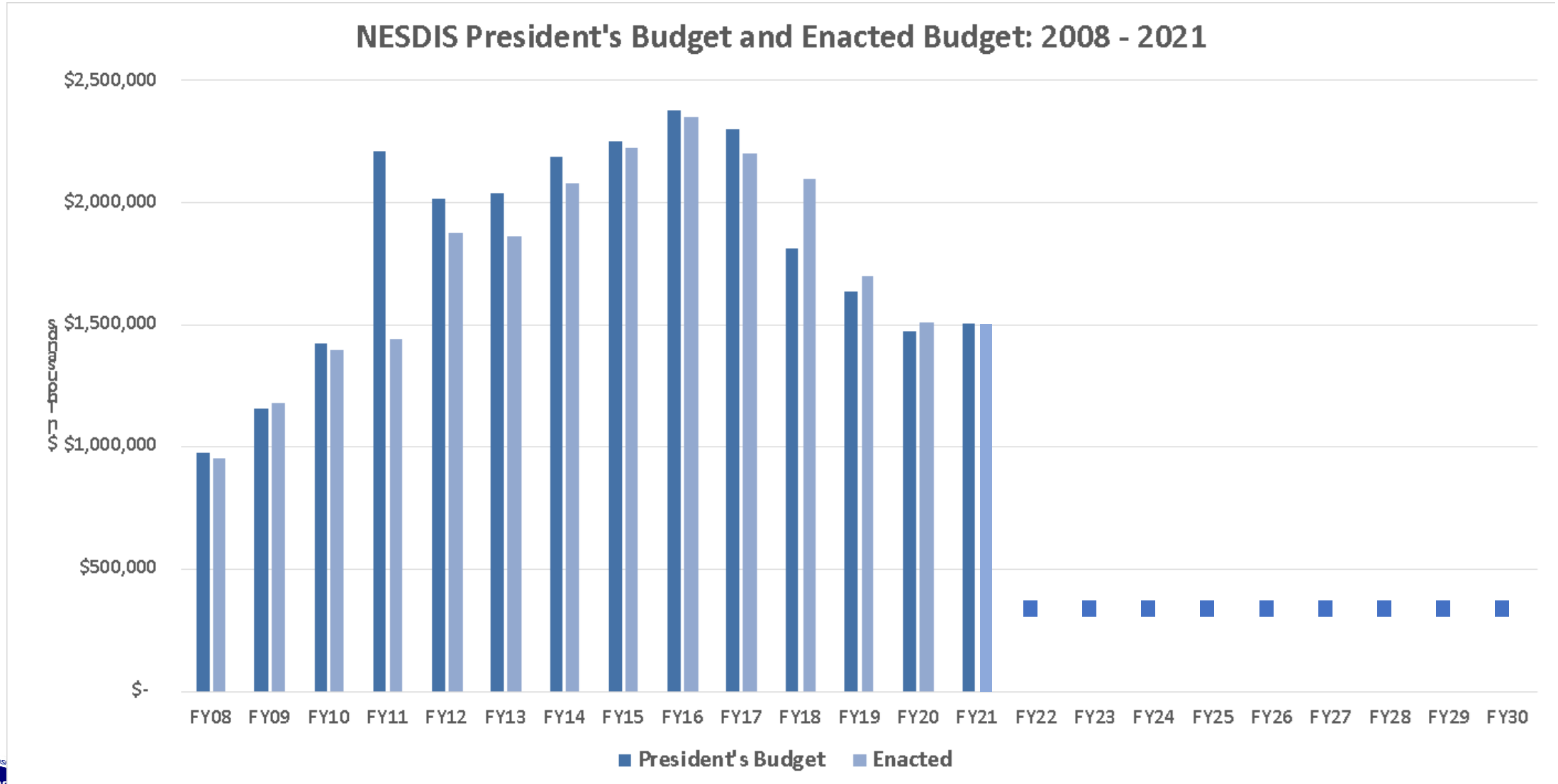
Flexibility

- Our Portfolios (GEO, LEO, SWO) allows us to manage risk across the different elements of each
- Creation of wedges in Common Services enables more rapid partner data exploitation

Requirements and User Engagement

- Refresh mission requirements to intentionally include whole earth system observations – ocean, biosystems.

NESDIS Future Mission Needs



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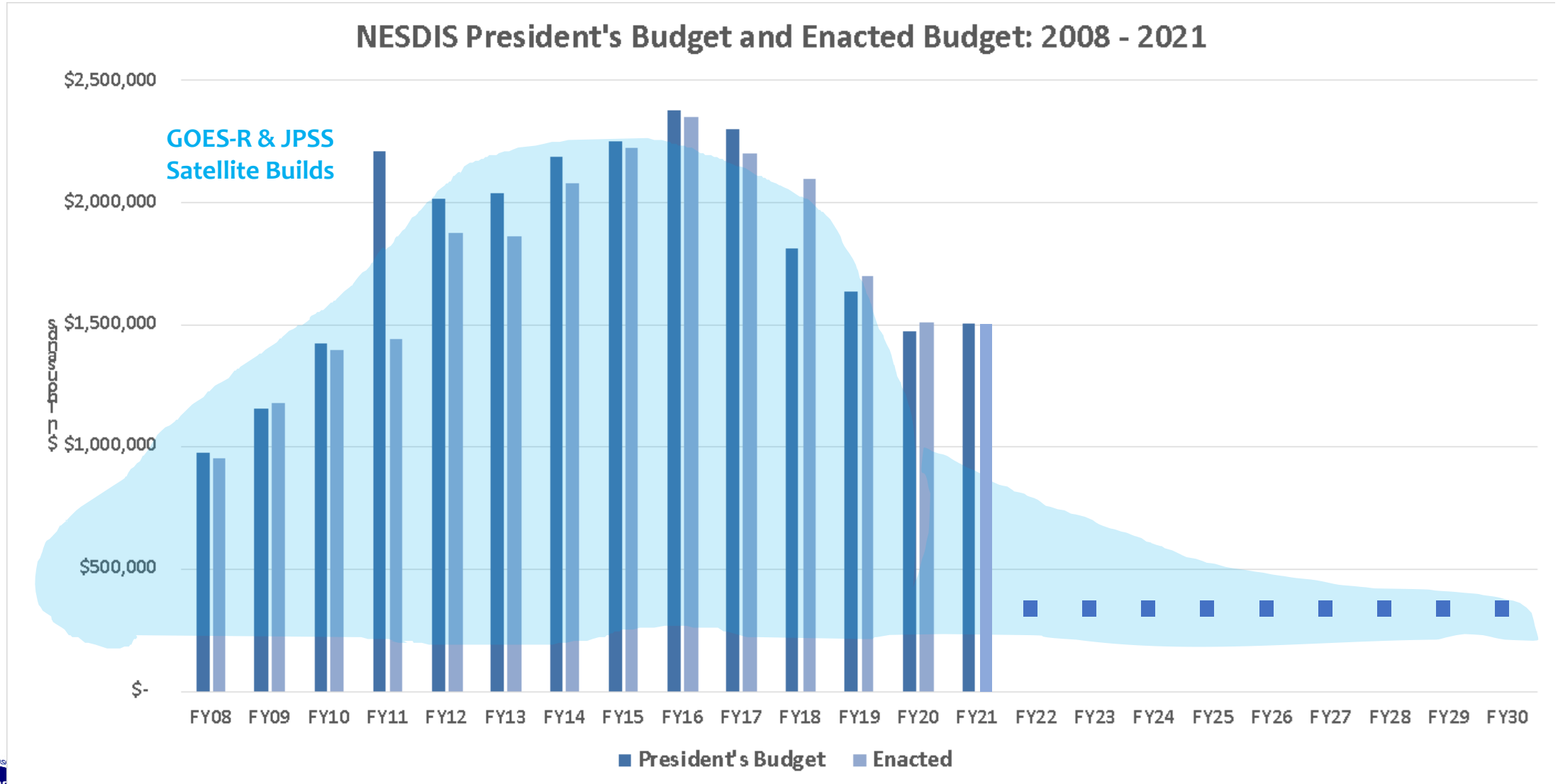

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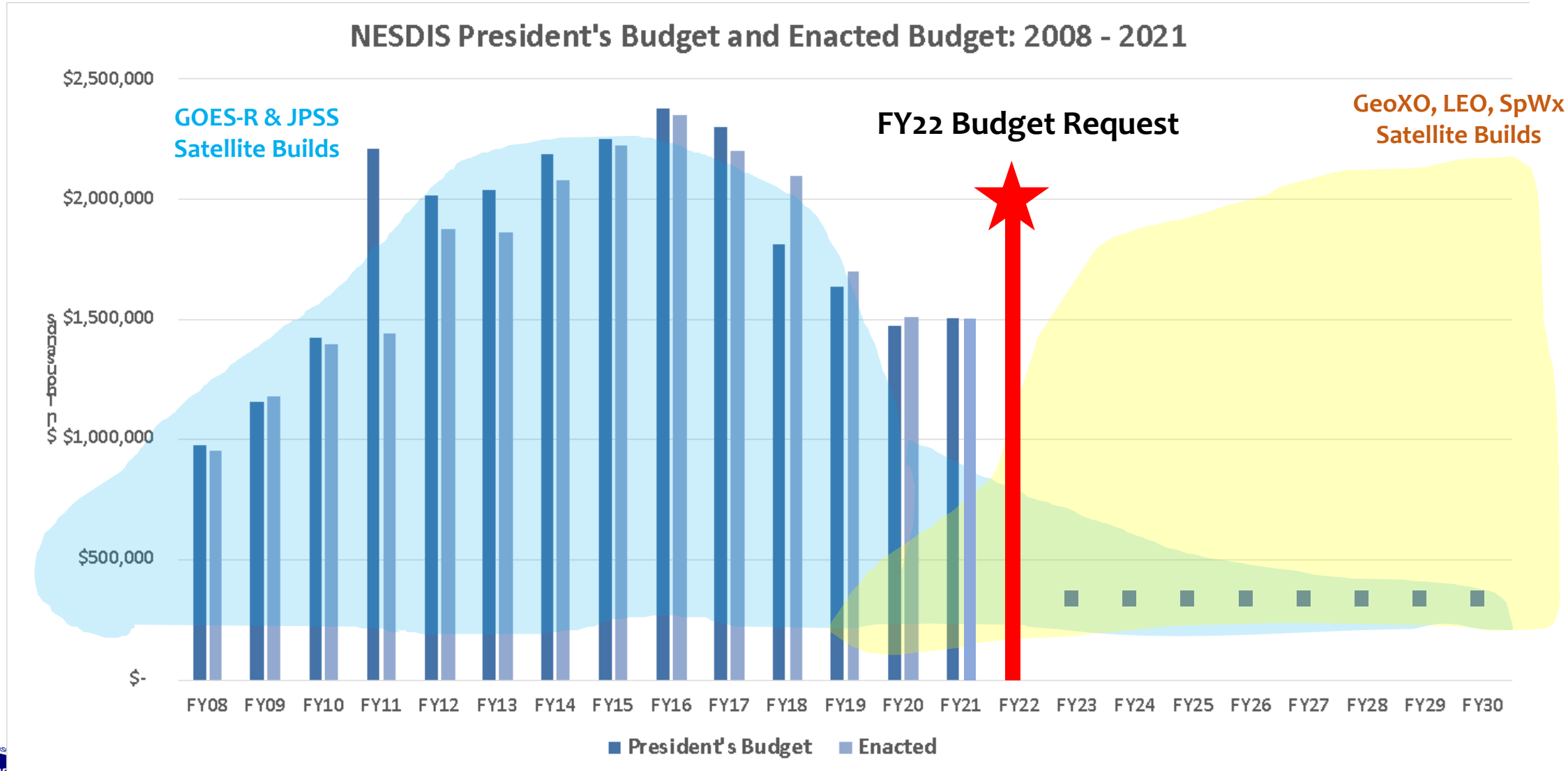
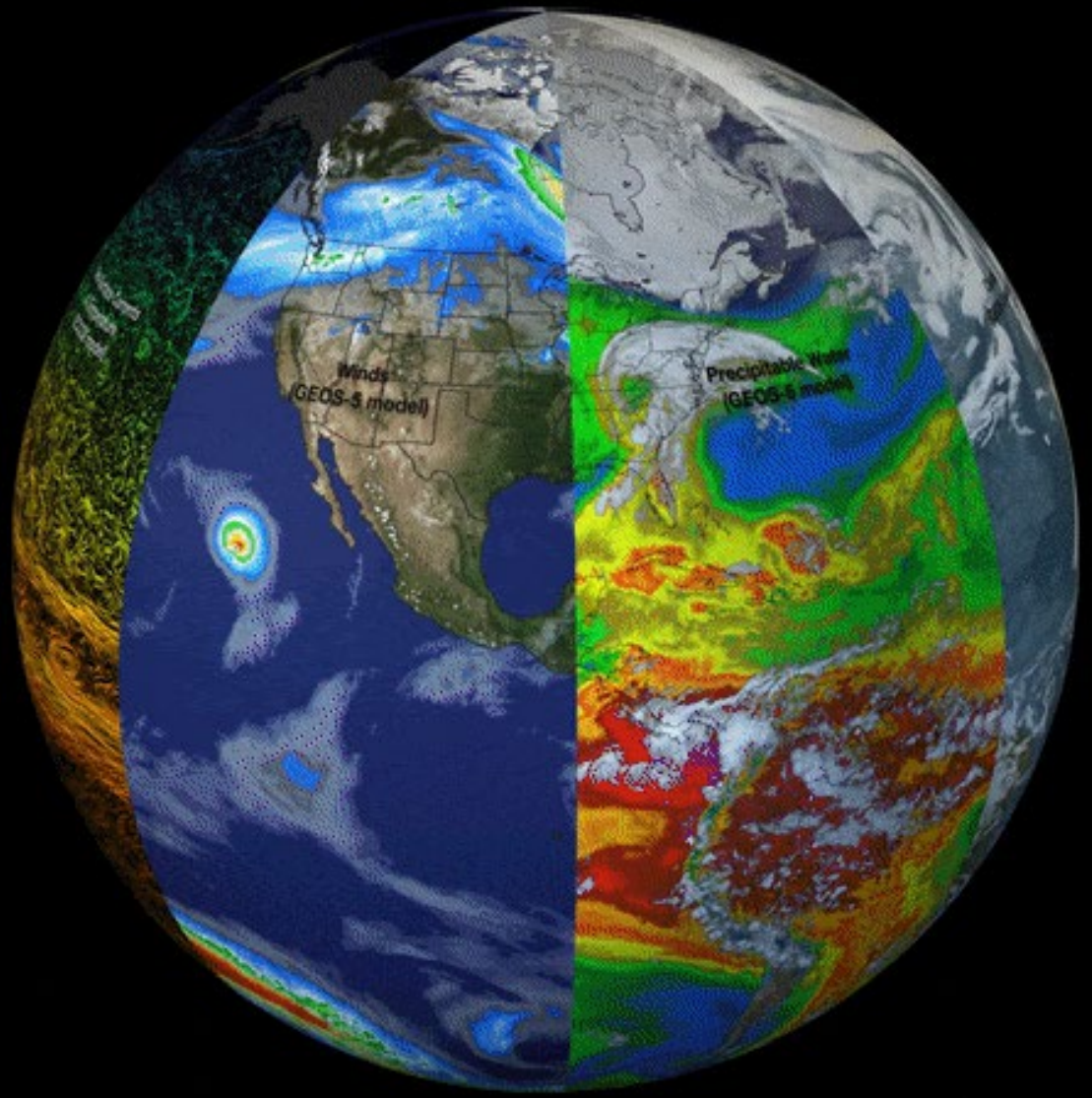


NOAA & Partners: Addressing the Climate and Environmental Challenge

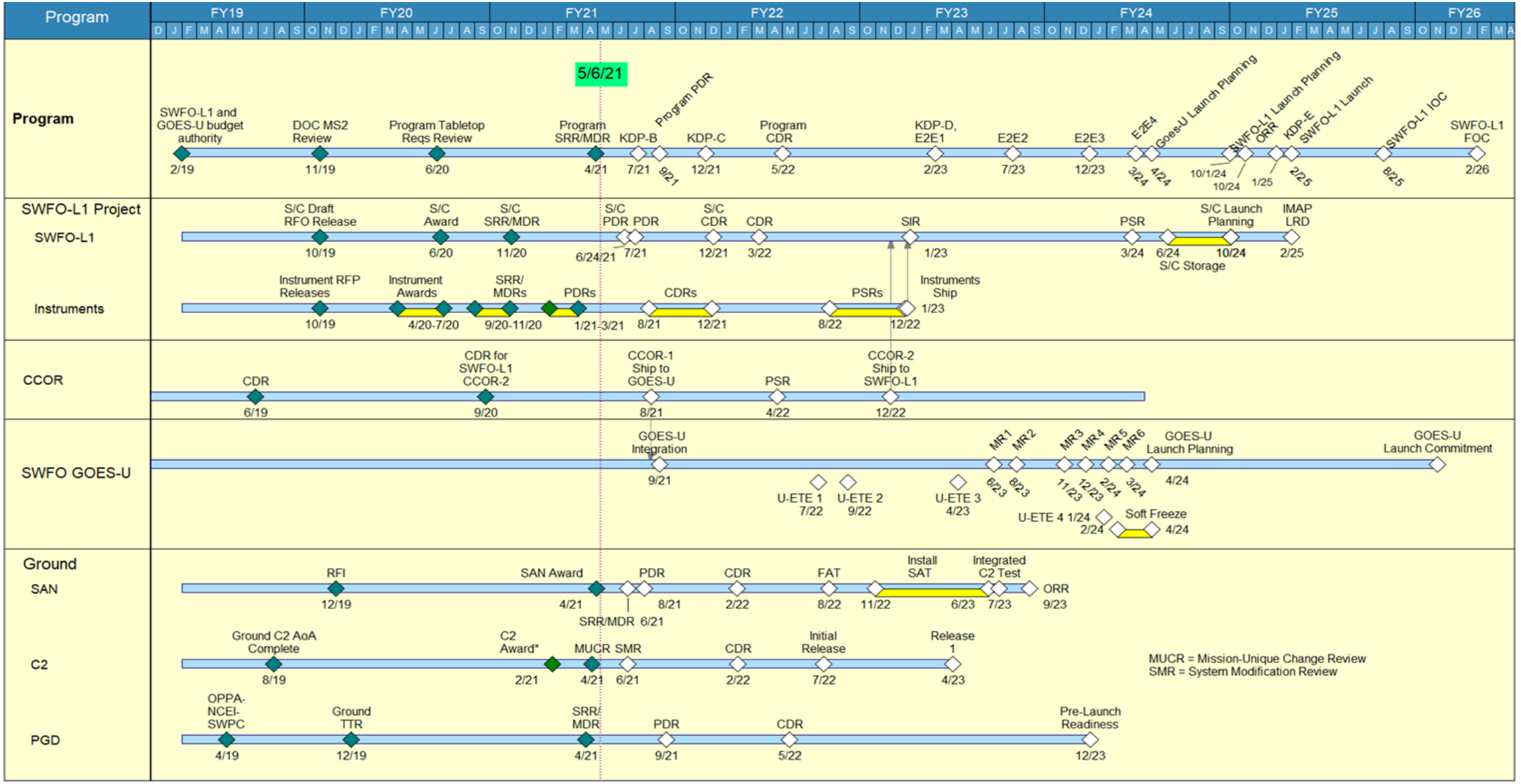
- Engaging with our users to better understand and meet their needs
- Working with our US partners, NASA and DOD, to exploit new and emerging technologies in new observing systems and refreshing Information Technology
- Expanding commercial and international partnerships to deliver a resilient and high-performing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



THANK YOU

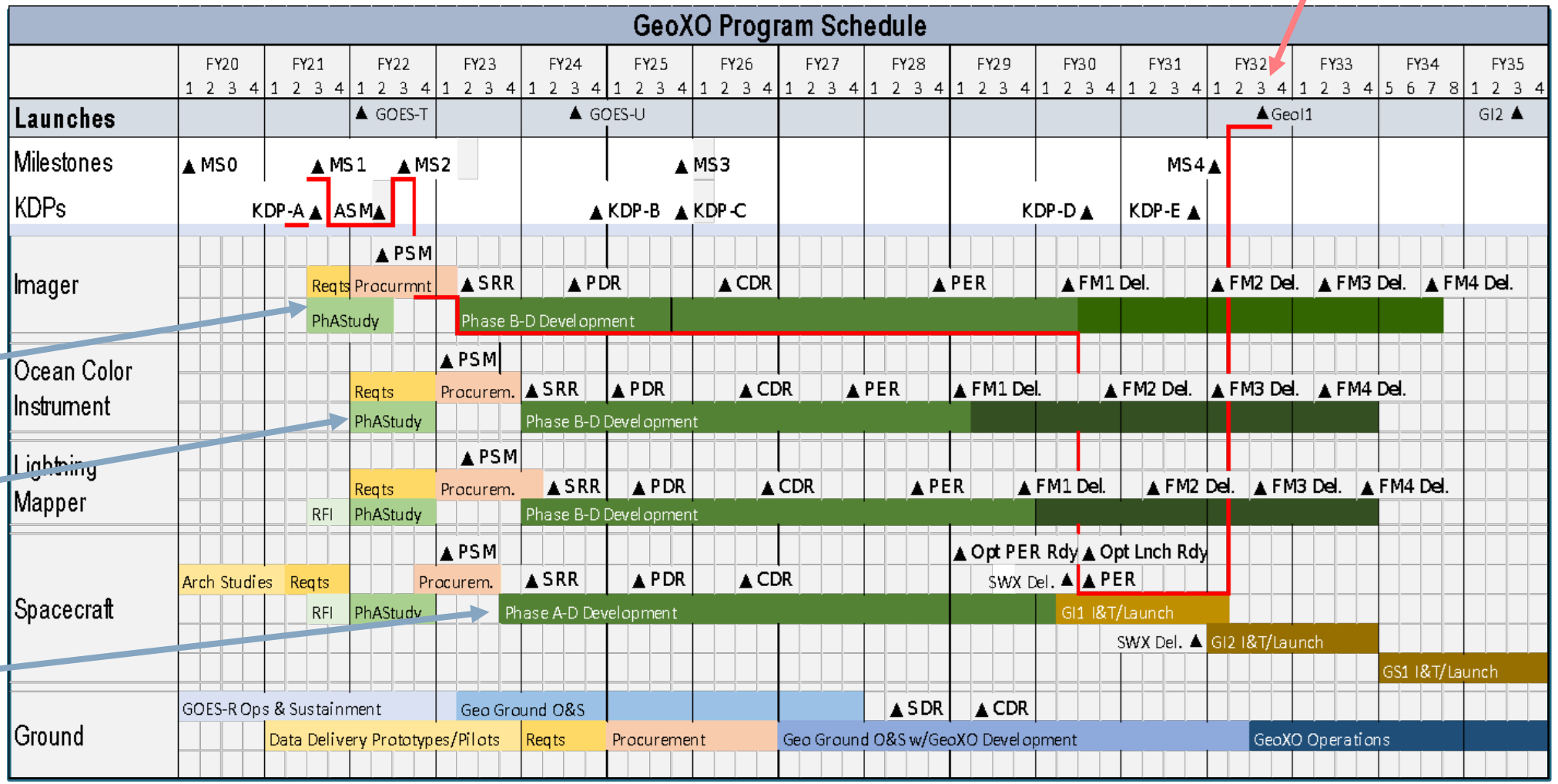
BACKUP

SWFO Program Integrated Master Schedule



GEO-XO Program Schedule

Notional - pending approval



FY21: Imager Phase A studies

FY22: other Phase A studies and Program ramp up

Development contract awards start in FY23

Sounder and AC instruments not shown for readability: Sounder follows similar timeline as Imager; AC follows LM.

JPSS Program Addresses Multiple Primary Mission Objectives Thru 2038