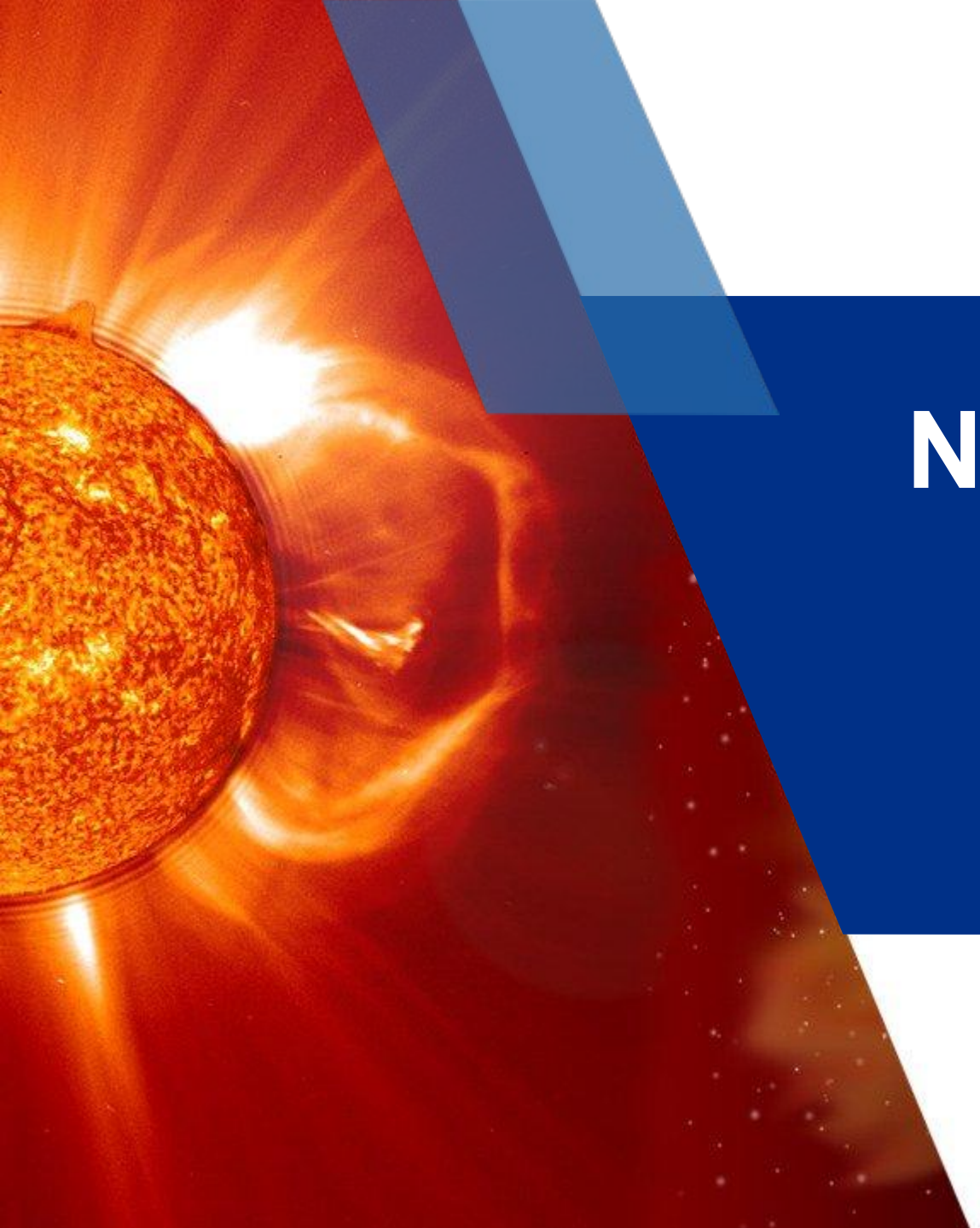


NOAA Space Weather

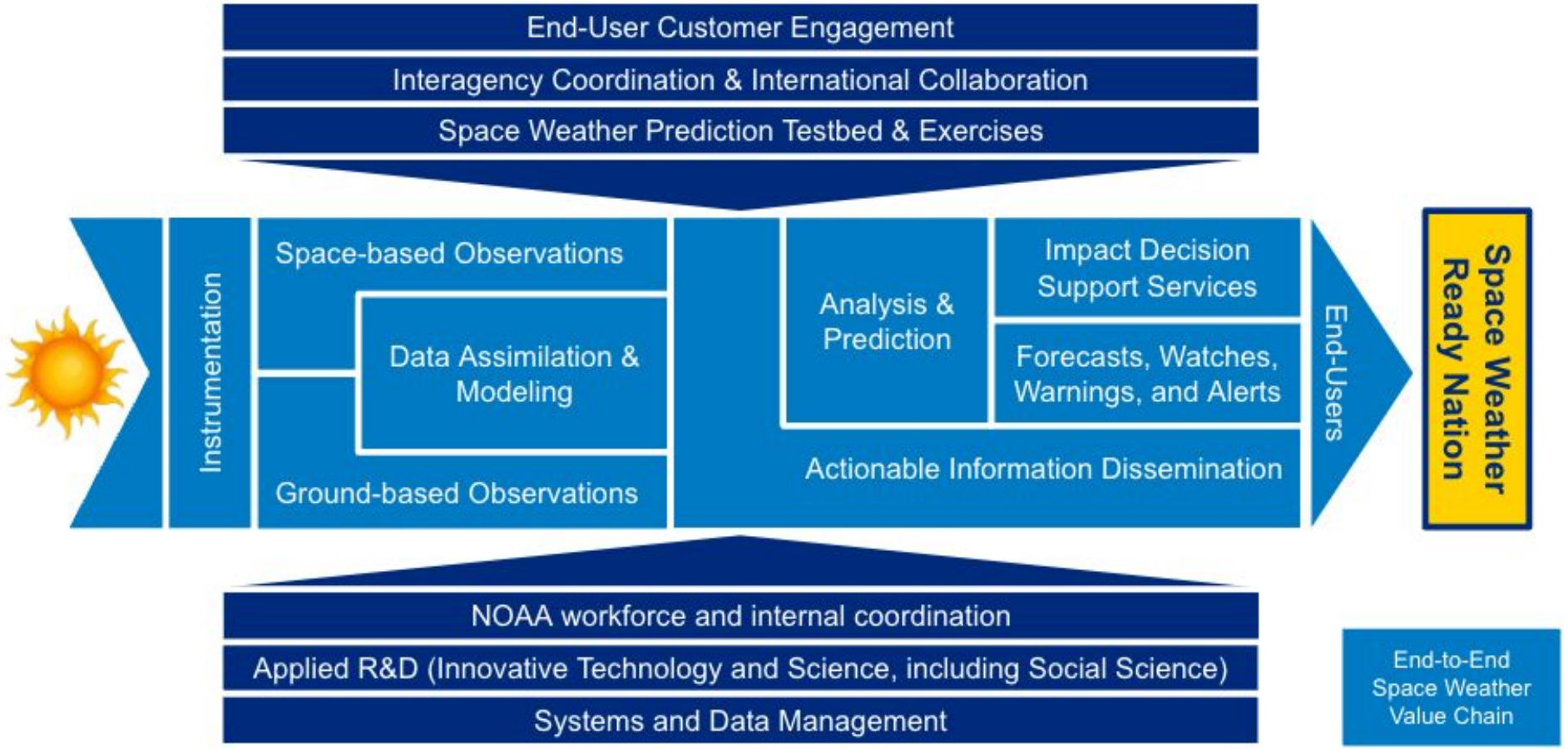
Presented to CSSP, NASEM Science Week 2025
Jinni Meehan, NWS SWPC
James Spann, NESDIS SWO
Laurel Rachmeler, NESDIS NCEI

The One-NOAA Space Weather Strategy

One-NOAA Strategy aligns priorities and builds connective tissue across line offices.

- NESDIS - Satellite and Data focus
  - SWO - Satellite Missions
  - NCEI - Algorithm Development, Data Validation, Archive & Access, SWx Subject Matter Expertise
- NWS - Forecast and Operations focus
- OAR - (potential) Research and Modeling focus

One-NOAA strategy underway to address Space Weather Advisory Group (SWAG) concerns about applied research and meet the Space Weather Ready Nation Directive



NOAA's Responsibilities PROSWIFT* §60601(a)(2)(A)

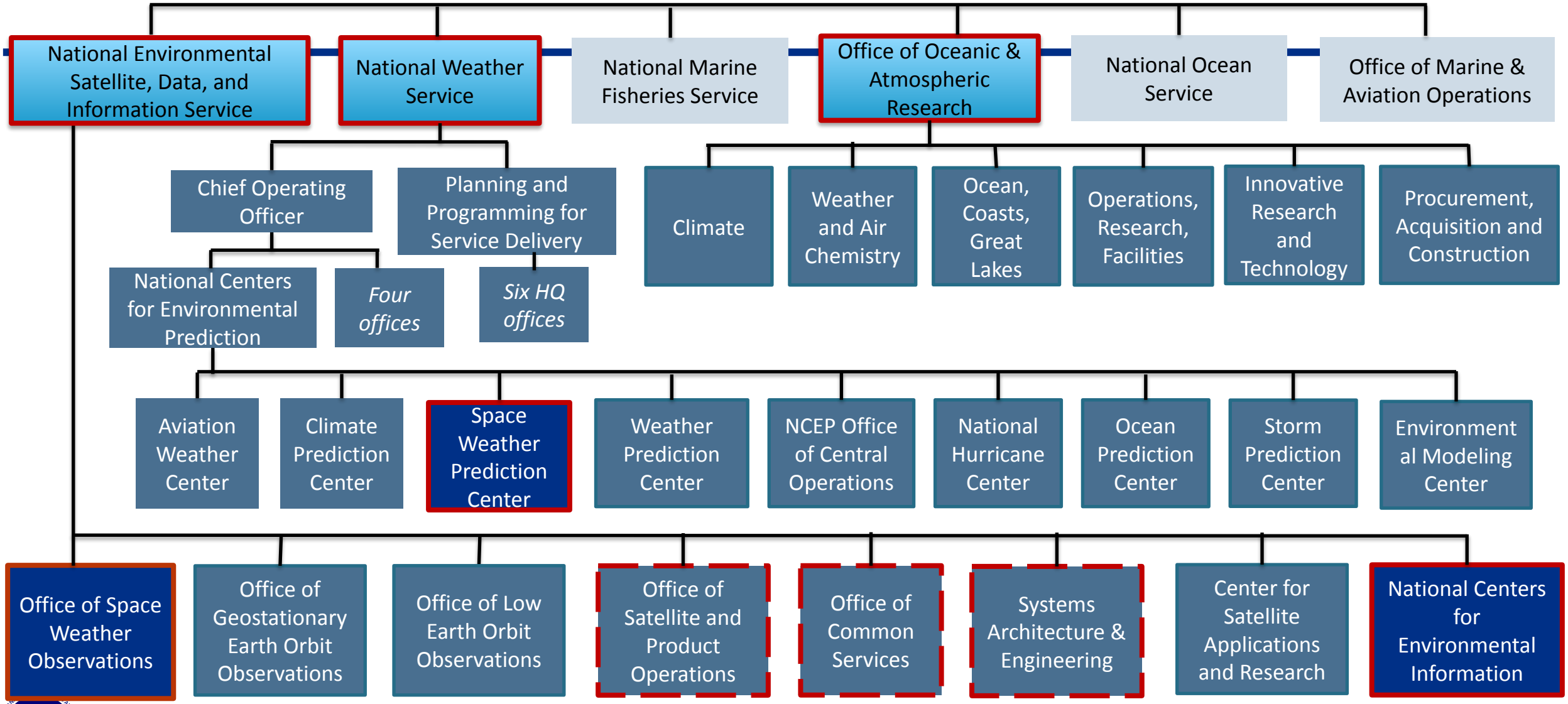
- Provide operational space weather monitoring, forecasting, and long-term data archiving and access for civil applications
  - Monitoring (NESDIS Office of Space Weather Observations - SWO),
  - Forecasting (NWS Space Weather Prediction Center - SWPC), and
  - Long-term data archiving and access (NESDIS National Centers for Environmental Information - NCEI) for civil applications
  - Maintain ground-based and space-based assets to provide observations needed for space weather forecasting, prediction, and warnings
    - Ground-based (NWS) and
    - Space-based (NESDIS) assets to provide observations (SWO) needed for space weather forecasting, prediction, and warnings (SWPC)
- Provide research to support operational responsibilities
  - To support (Oceanic and Atmospheric Research – OAR, potential)
  - Operational responsibilities (NWS SWPC)
- Develop requirements for space weather forecasting technologies and science
  - Space weather forecasting technologies (SWO observations, SWPC modelling) and
  - Science (OAR, potential)

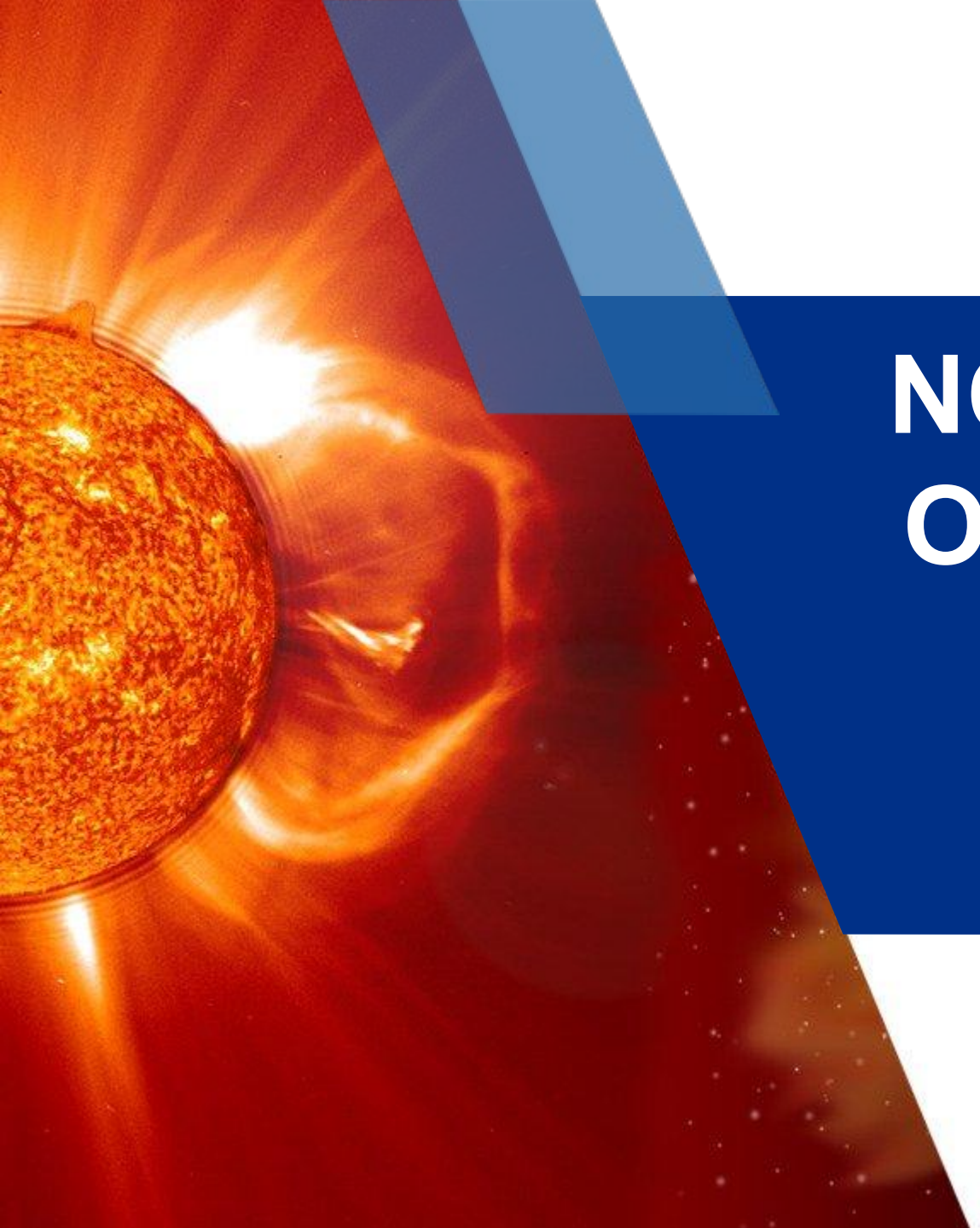
* 2020 Promoting Research and Observations of Space Weather to Improve the Forecasting of Tomorrow (PROSWIFT) Act.

NOAA Space Weather current and future

- As with all Federal Agencies, NOAA is facing a series of personnel and budget reduction exercises and impacts.
- The Department of Commerce is reviewing all of the critical functions that NOAA currently performs—including space weather measurements and platforms.
  - This adds uncertainty to long term NOAA plans and resources.
- The One-NOAA SWx group will continue to work together to provide timely and accurate information to comply with all of these activities.

NOAA Line Offices





NOAA Space Weather Observations Update

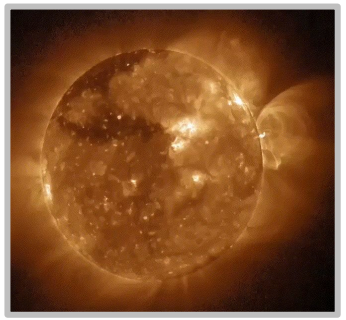
Presented to CSSP, NASEM Science Week 2025

Dr. James Spann, Senior Scientist
NOAA/NESDIS Office of Space Weather Observations

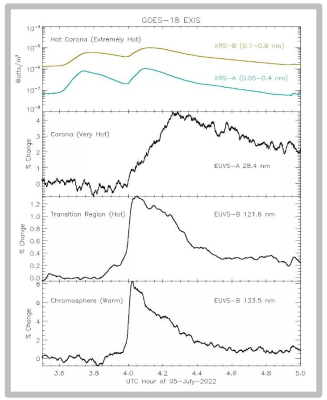
NOAA Space Weather Observations Update

- CCOR-1 launched on GOES-19 on June 25, 2024 and NOAA publicly released the first images from the instruments on October 22, 2024. GOES-19 is planned to become operational on April 4.
- SWFO-L1 is planned to launch in September 2025 and will feature CCOR-2 and numerous other Space Weather instruments including a Solar Wind Plasma Sensor (SWiPS), Suprathermal Ion Sensor(STIS), Magnetometer(MAG).
- The SOL project received Key Decision Point B (KDP-B) approval in December 2024.
- Space Weather Next GEO series requirement and concept definition work is ongoing.

Space Weather Follow On Program



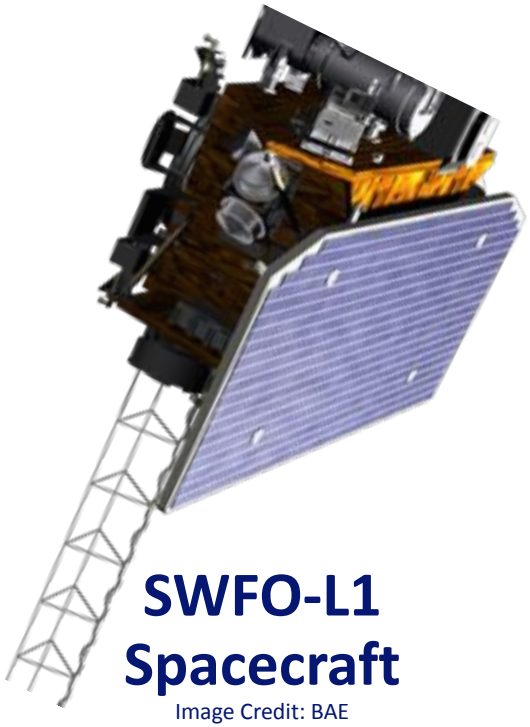
GOES-16 SUVI



GOES-18 EXIS

CCOR-1 integration onto GOES-19
Image Credit: Lockheed Martin

CCOR-2 on SWFO-L1
Together with:
Solar Wind Plasma Ion Sensor
Magnetometer



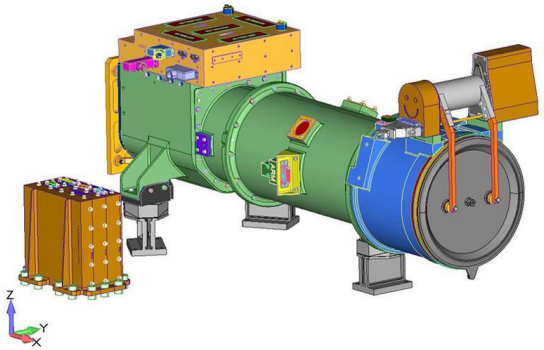
SWFO-L1 Spacecraft
Image Credit: BAE

Rideshare on NASA's IMAP mission
Becomes SOL1 once operational

Space Weather Next Program

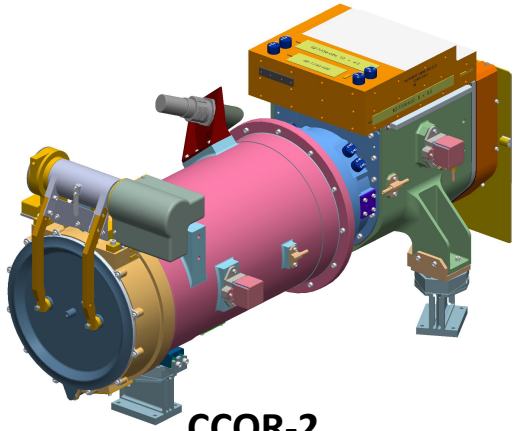
- Planning for **continuity** and enhanced capability with **observations** from:
  a. Solar Observations at L1 (SOL) Series - L1 extended continuity
  b. L5 Orbits – ESA Partner
  c. Geostationary Orbit
  d. Low Earth Orbit
- Development of Space Weather Ground Support Networks

SWFO: State-of-the-Art Heliophysics Instruments



CCOR-1

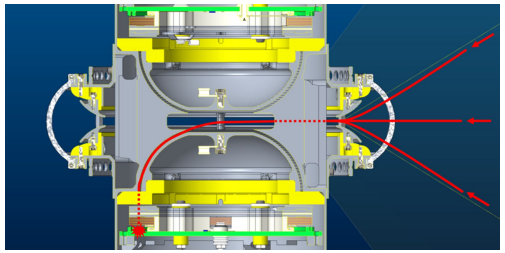
Compact Coronagraphs (CCORs): Developed by Naval Research Lab (NRL), the telescope will be used to observe the solar corona and detect coronal mass ejections (CMEs) and other structures. CCOR-1 will fly on the GOES-U satellite and a nearly identical CCOR-2 on SWFO-L1.



CCOR-2

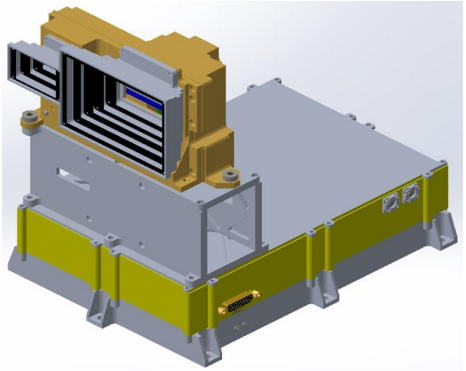
U.S. NAVAL RESEARCH LABORATORY

Solar Wind Plasma Sensor (SWiPS): Built by Southwest Research Institute (SwRI), it will measure properties of the solar wind plasma flowing past SWFO-L1, such as density, velocity, and temperature.



SwRI

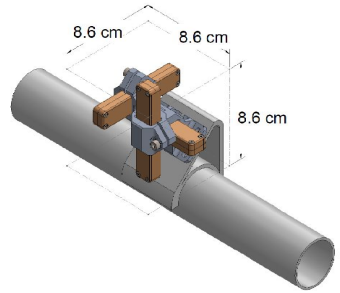
Suprathermal Ion Sensor (STIS): Developed by University of California, Berkeley, it will collect fast ions in the solar wind.



Berkeley UNIVERSITY OF CALIFORNIA

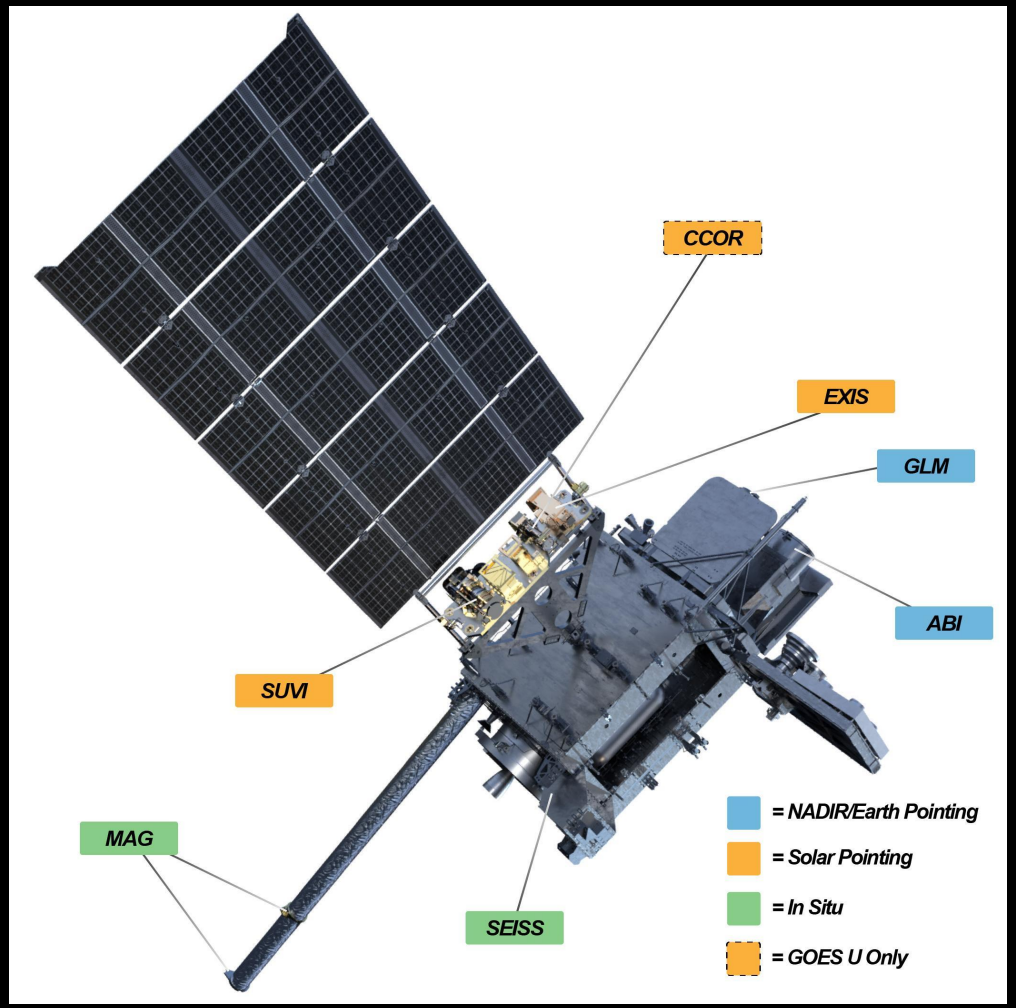
Magnetometer (MAG): Developed by the University of New Hampshire and SwRI, it will measure the magnetic field carried by the solar wind.

University of New Hampshire

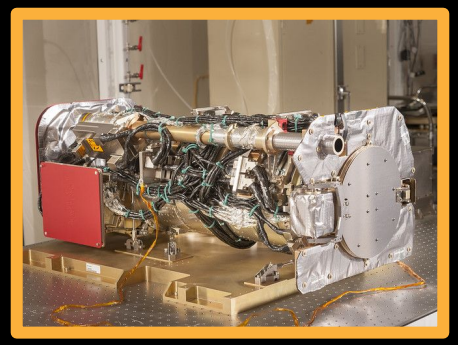


SwRI

GOES-19 spacecraft hosts NOAA's first operational coronagraph



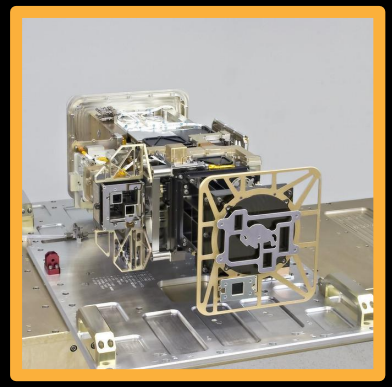
Rendering of the GOES-19 satellite



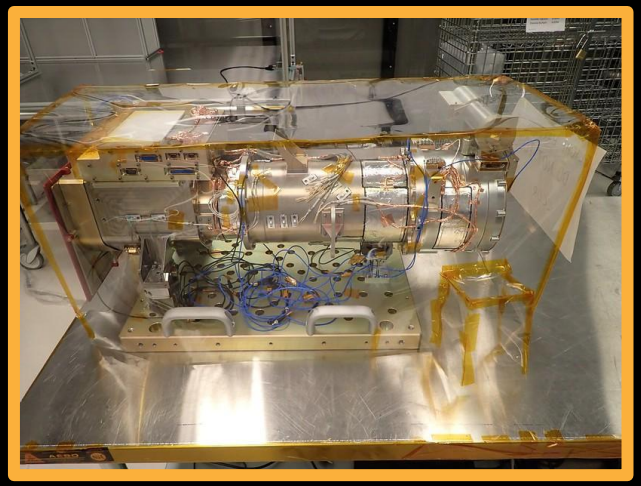
Solar Ultraviolet Imager (SUVI)

Magnetometer (MAG) Sensor

Space Environment In-Situ Suite (SEISS)

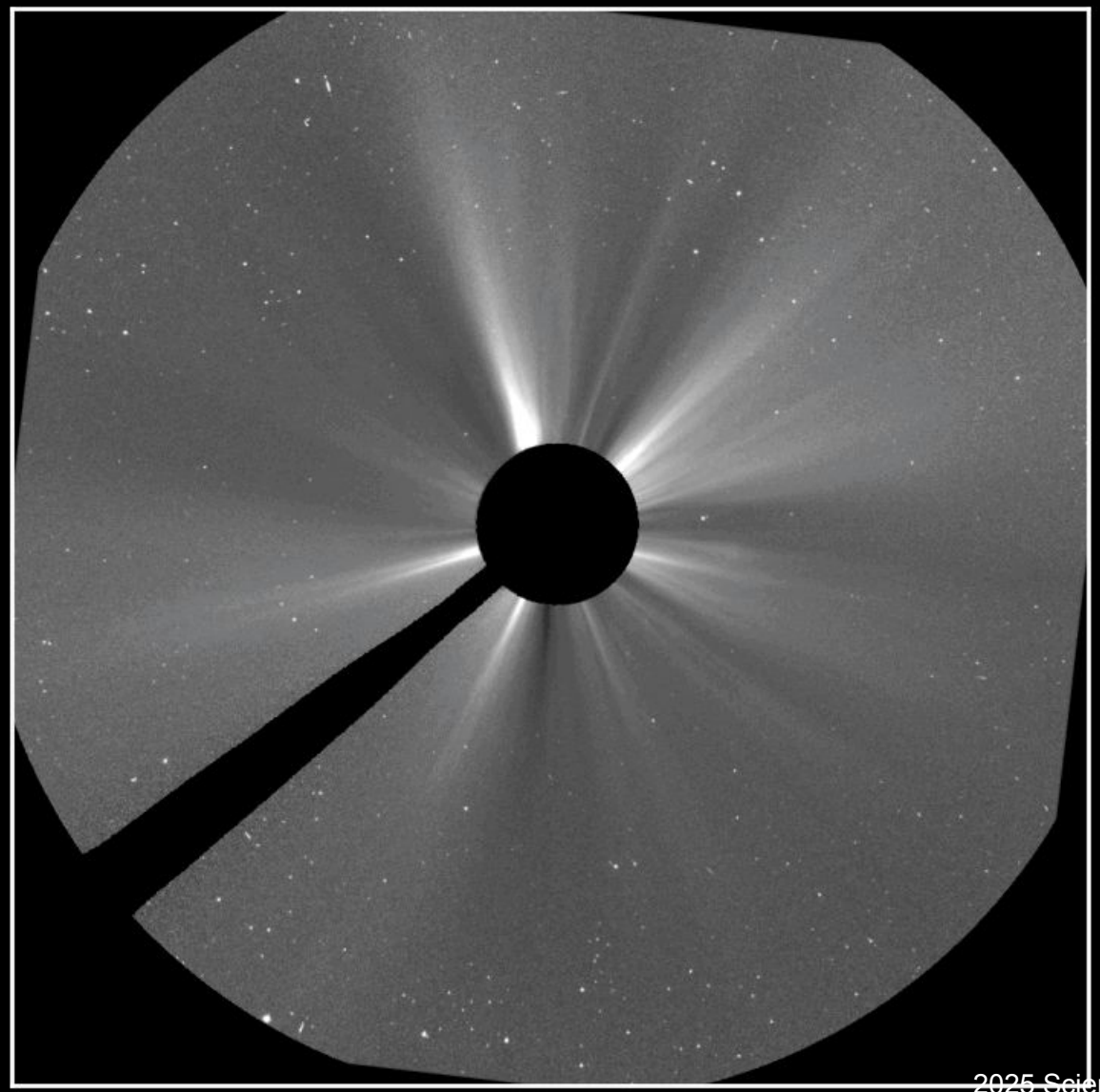


Extreme Ultraviolet and X-ray Irradiance Sensors (EXIS)

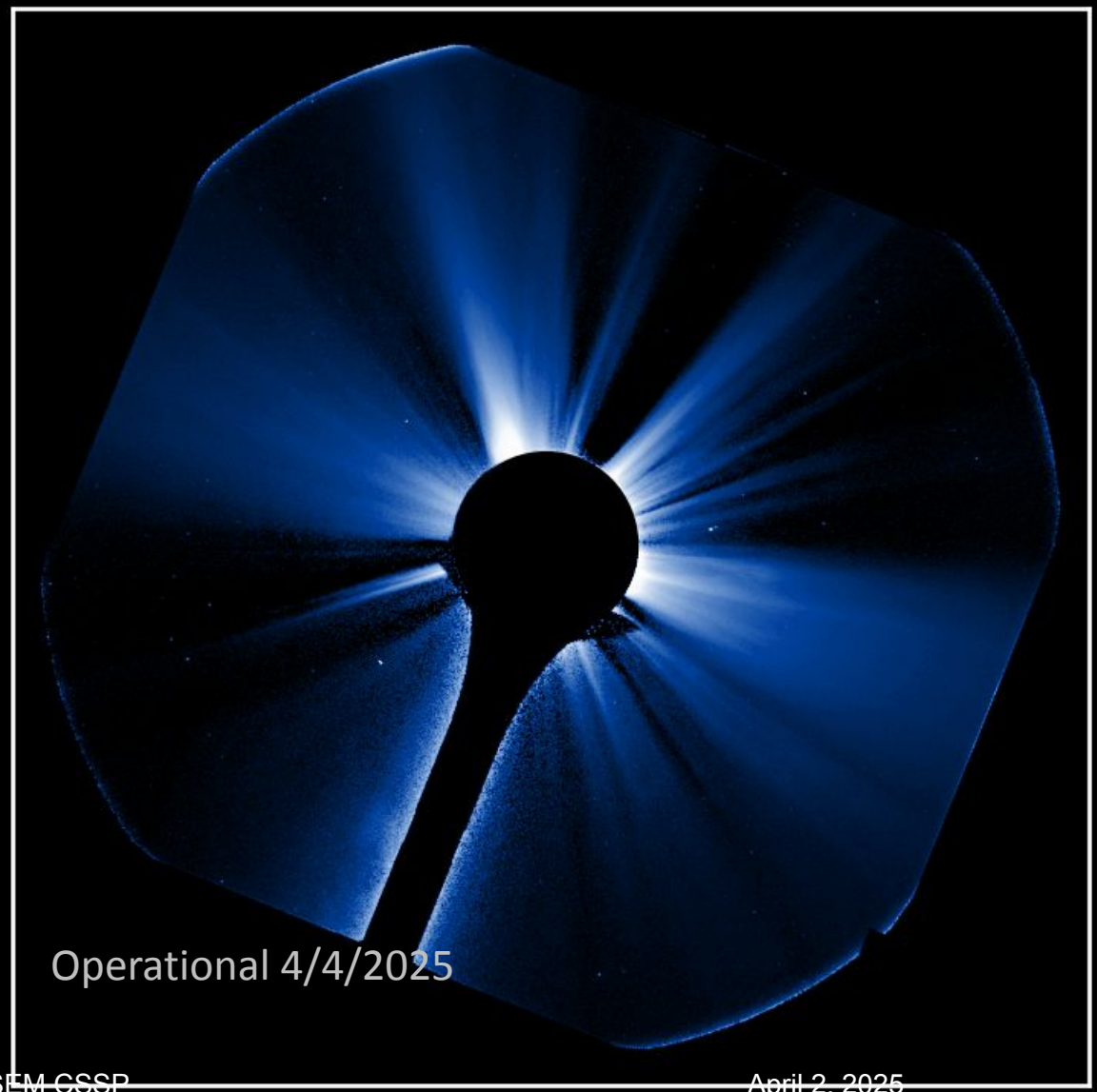


Compact Coronagraph (CCOR)

LASCO/C3
2024-11-09 07:06:08



GOES-19/CCOR-1
2024-11-09 07:00:20

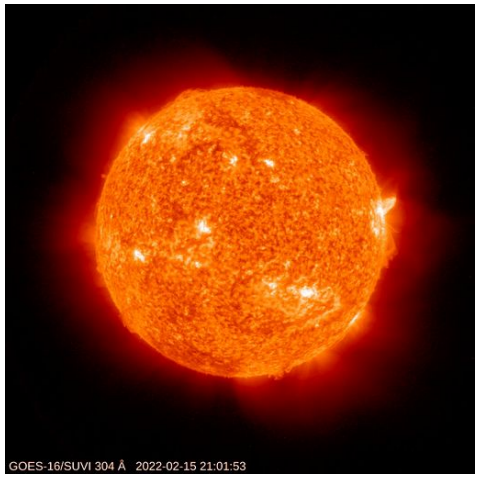


Operational 4/4/2025

Space Weather Next (SW Next) Program

SW Next will **maintain and extend** space weather observations from a range of different observing points, selected to most efficiently provide the comprehensive knowledge of the Sun and the near-Earth space environment.

✓ Planning for **continuity of observations** from:
- L1 and L5 orbits
- Geostationary orbit
- Low Earth orbit
- Space Weather ground support networks



✓ **Pre-formulation underway**
- GEO Series requirement and concept definition work is ongoing
- L5 Project preparing for System Requirement Review

✓ **Project formulation**
- SOL Project received Key Decision Point B (KDP-B) approval in December 2024

✓ **Development** of Ground Services underway

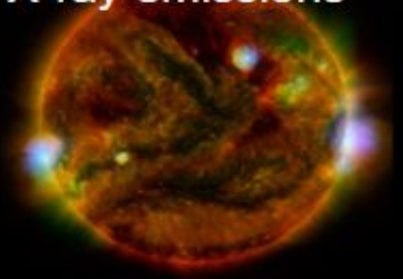
✓ **Engaging stakeholders** through user outreach, partnerships, and market research

SOL-A and SOL-B will become SOL-2 and SOL-3, sustain SWFO-L1 observations, and address critical NWS space weather needs

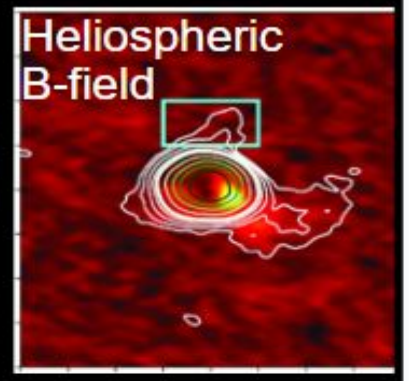
Two spacecraft, SOL-A and SOL-B on the Sun-Earth line at L1

Element	Status
Coronagraph	Contract awarded to Southwest Research Institute (SwRI) of San Antonio, TX
Solar Wind Plasma Sensor	Contract awarded to UNH in Durham, NH
Suprathermal Ion Sensor	Contract awarded to Johns Hopkins University's Applied Physics Laboratory (APL) of Laurel, MD
Magnetometer	Contract awarded to SwRI of San Antonio, TX
X-ray Flux Monitor	ESA-contributed, flown on SOL-A only
X-ray Irradiance	Solicitation to be developed for SOL-B
Spacecraft	Delivery order awarded to BAE Systems in Boulder, CO
Launch Vehicle	Through NASA LSP

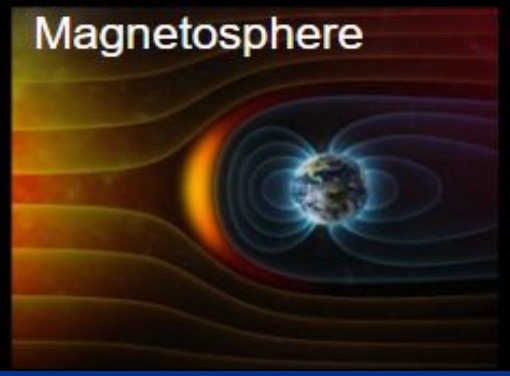
Solar Observations

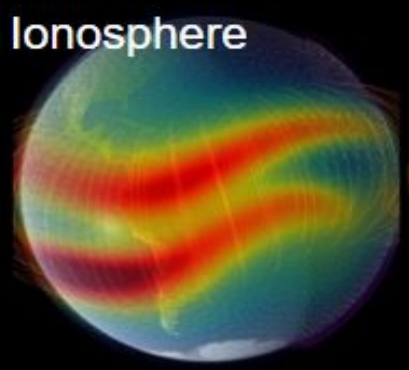


Heliospheric Observations

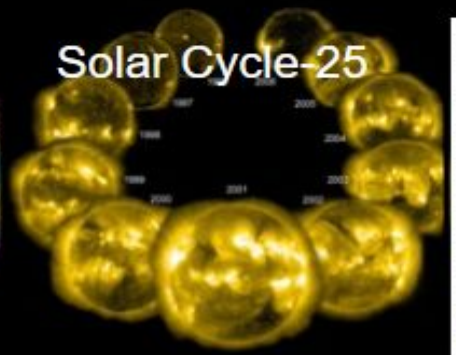


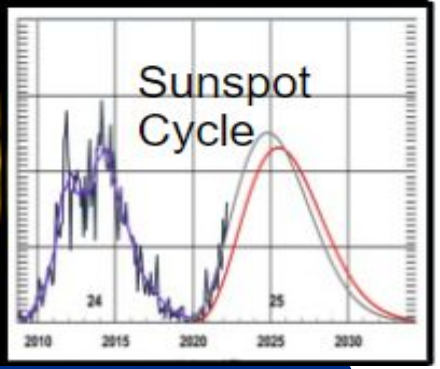
Drivers of Geospace Weather



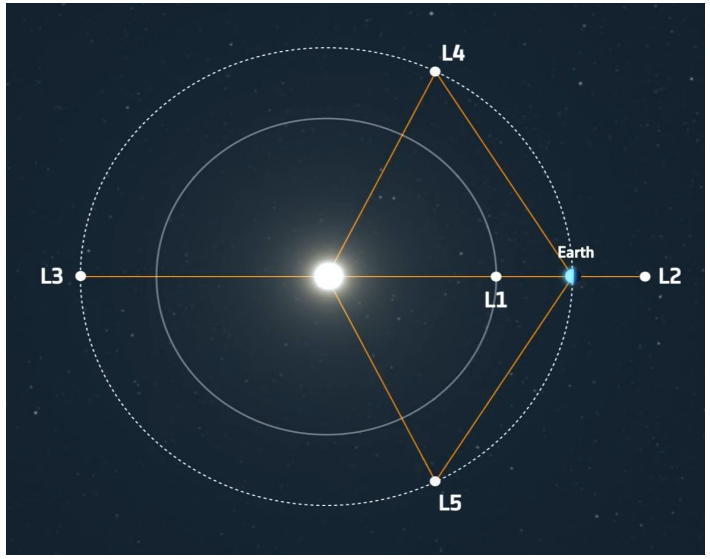


Long-Term Variations



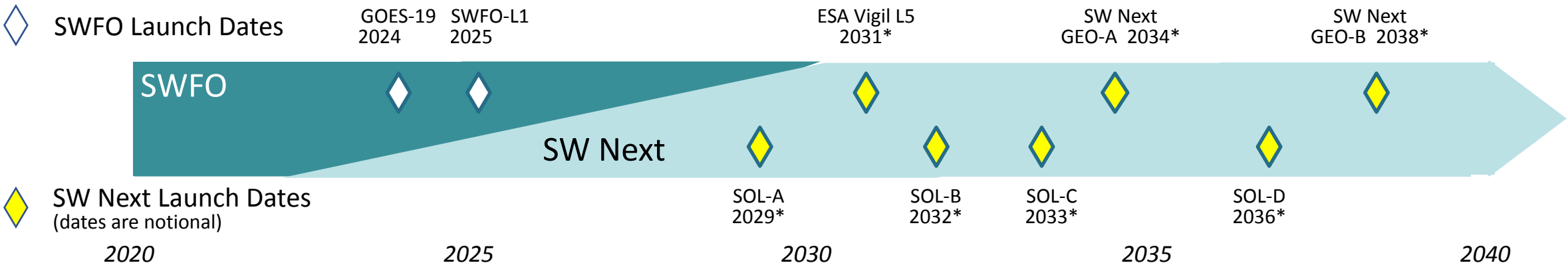


NOAA provision of a Compact Coronagraph (CCOR-3) to ESA's Vigil mission to L5

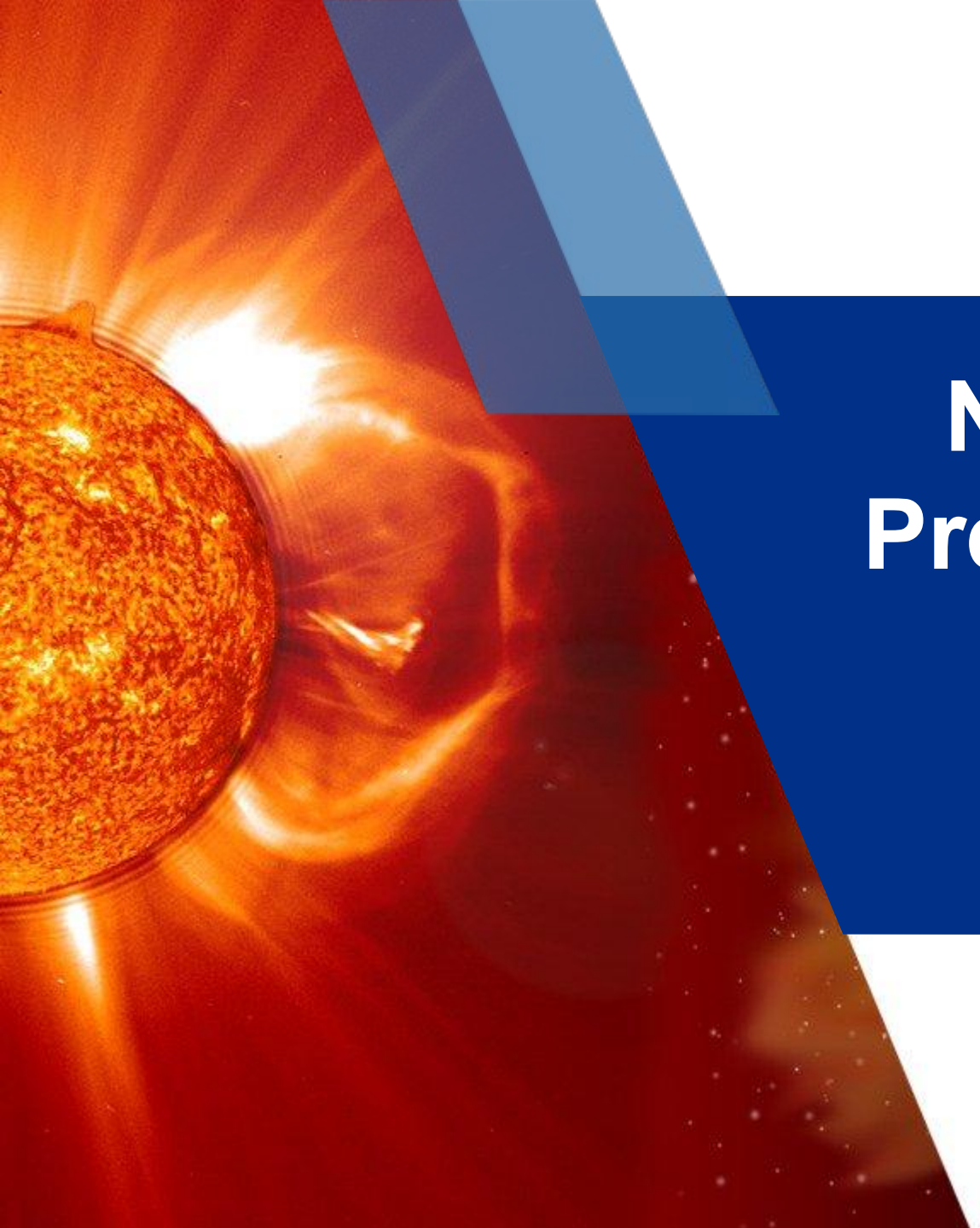


- CCOR-3 is being built by Naval Research Laboratories (NRL) as a near-copy of the CCOR-2, which is to fly on SWFO-L1.
- There is an agreement to exchange data from all SWFO and Vigil instruments
- The L5 Project will manage the CCOR-3 development effort, the integration of the instrument into the ESA mission, and the development of data services.
- Launch (planned) for 2031
- The first of its kind, Vigil will keep constant watch of the Sun where it can see the 'side' of the Sun and observe activity on the surface of the Sun days before it rotates into view from Earth.

NOAA Space Weather Fly Out Chart*



- *Current **notional, unofficial** flyout chart of our planned SWO architecture
- The SOL-A launch is planned to overlap with SWFO for calibration and validation
- Planned architecture supports resiliency of observations at L1 and at GEO for critical observations



NOAA Space Weather Prediction Center Update

Presented to CSSP, NASEM Science Week 2025

Dr. Jinni Meehan, National Space Weather Program Manager
NOAA/NWS

Building a Space Weather-Ready Nation!

NWS Mission - Protect life and property and enhance national economy

Space weather threatens critical infrastructure and human activities in space, with *significant* societal, economic, and national security impacts.

NOAA will provide *operational* space weather monitoring and forecasting, maintains ground-based and space-based assets, provides research to support operations, and develops requirements for space weather forecasting.

PROSWIFT Act §60601

Increasing & Emerging Vulnerabilities

Arctic

Greater access and geopolitical importance

Satellites

Exponential Growth in Low Earth Orbit

Human Spaceflight

No natural protection on the Moon, Mars, and deep Space

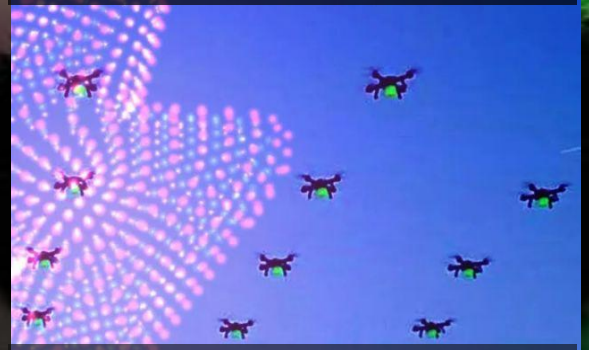
Emergency Management

Emphasis on resilience and preparedness

Agricultural

Growing reliance on precision GPS

Autonomous Vehicles



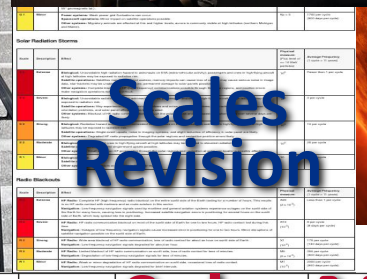
Increased use in commercial, public safety, emergency response, and defense.

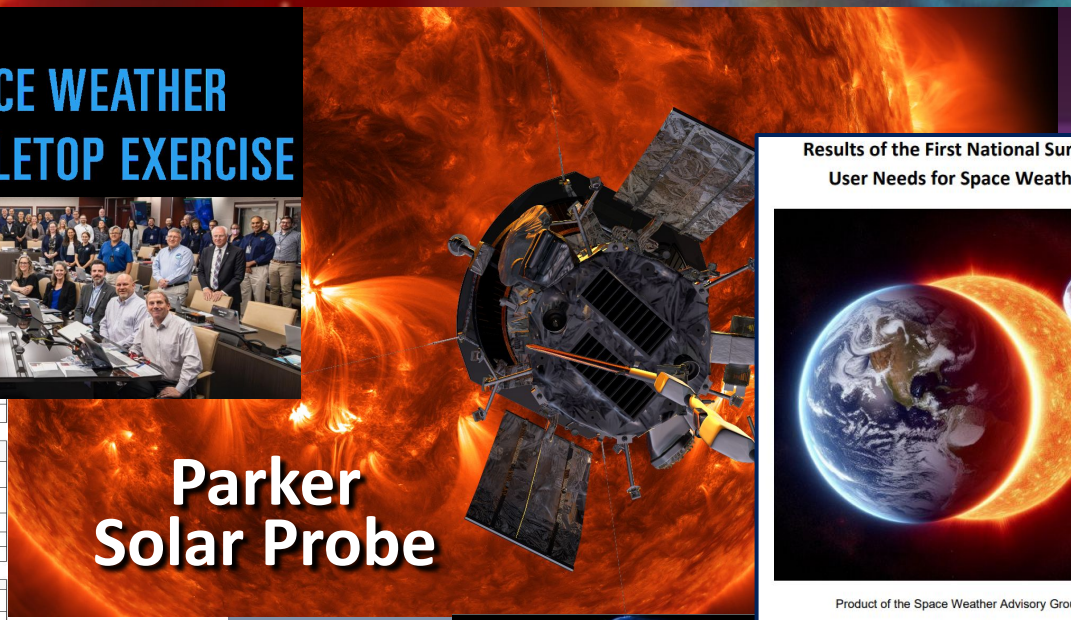
National Security

Space weather threatens the reliability of critical systems


Space
Weather
Summit


SPACE WEATHER
TABLETOP EXERCISE

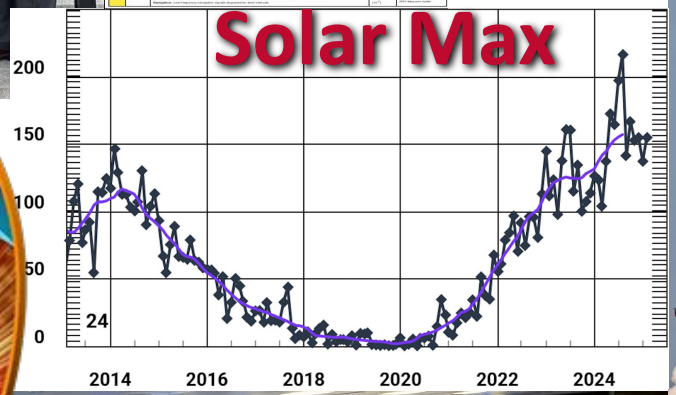

Scales
Revision


Parker
Solar Probe

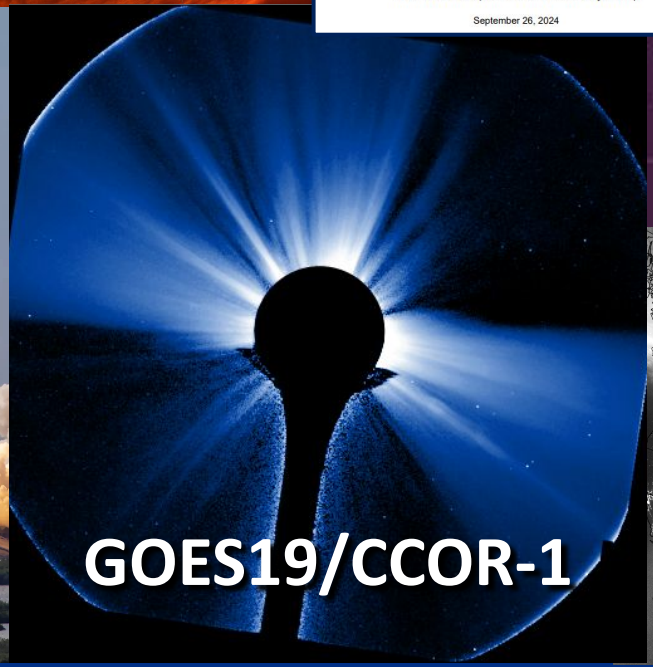
Results of the First National Survey of
User Needs for Space Weather
Product of the Space Weather Advisory Group
September 26, 2024

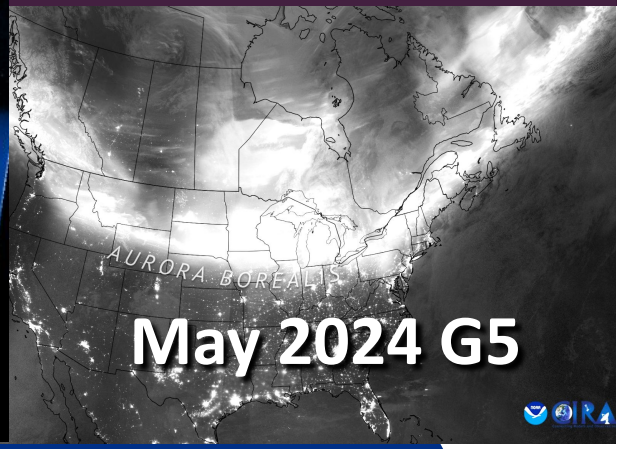

NATIONAL ACADEMIES
Next Decade of Discovery
in Solar and Space Physics
Exploring and Safeguarding Humanity's Home in Space
Consensus Study Report


PUNCH

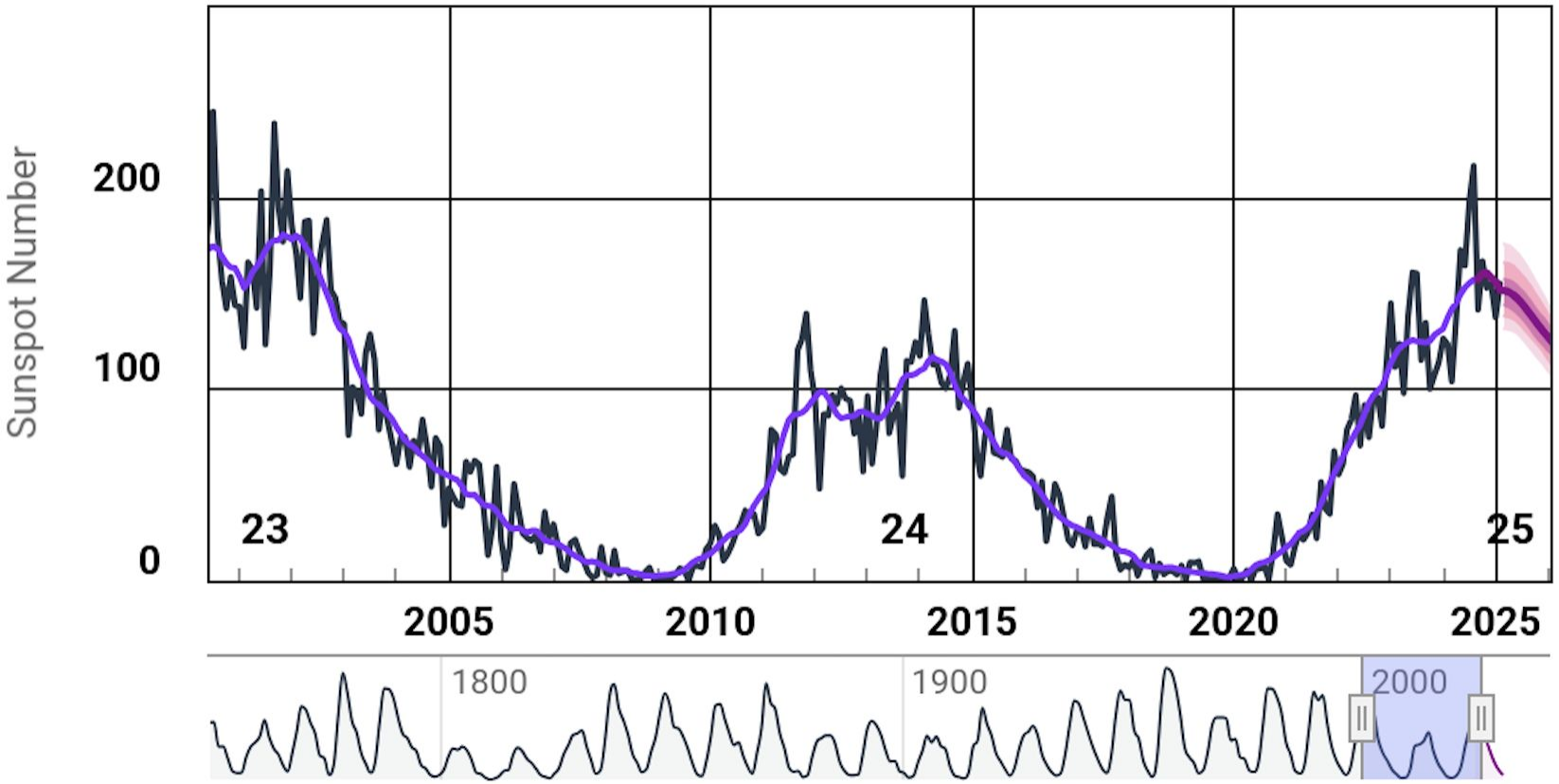

Solar Max
200
150
100
50
0
24
2014
2016
2018
2020
2022
2024


SPACE WEATHER PREDICTION TESTBED


GOES19/CCOR-1


AURORA BOREALIS
May 2024 G5

A Dynamic & Transformative Time



2024 Most Active in Solar Cycle 25

May 2024 G5 Storm Strongest in 20+ years

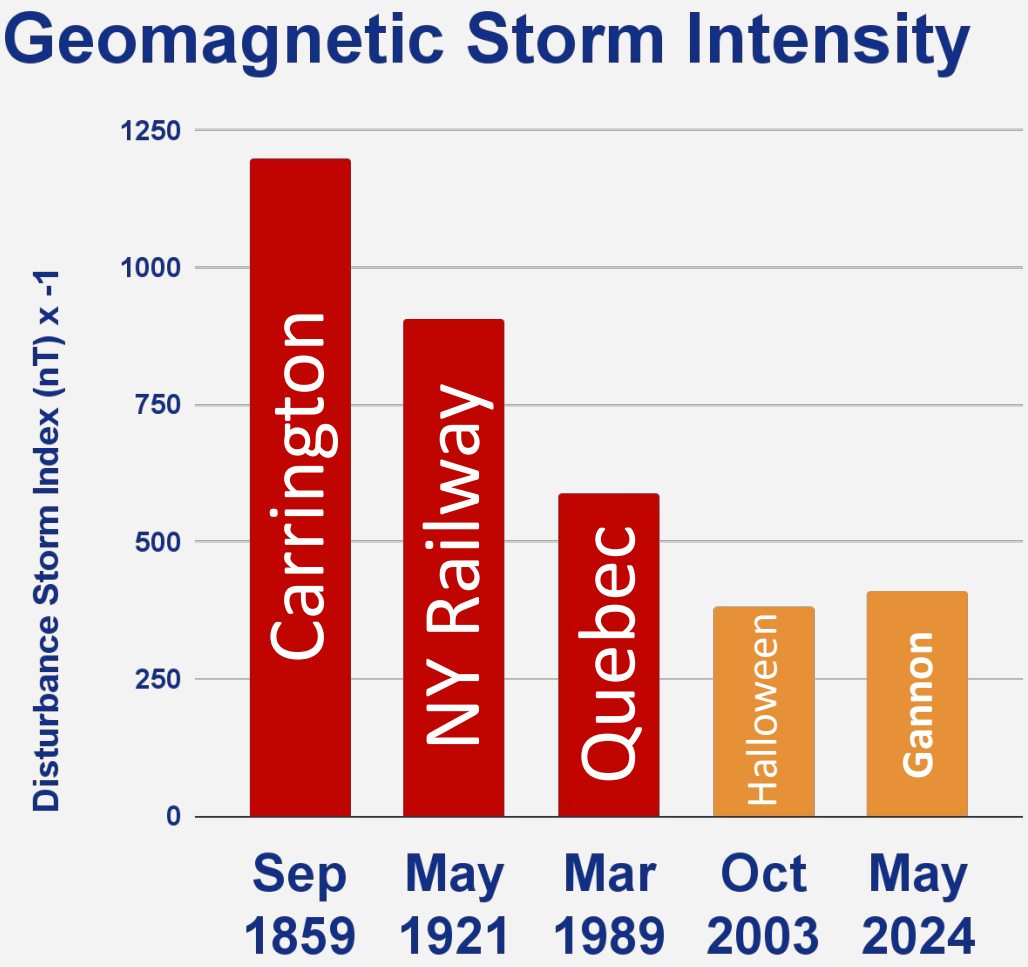
This was not the “Big One”

A decade of preparedness paid off

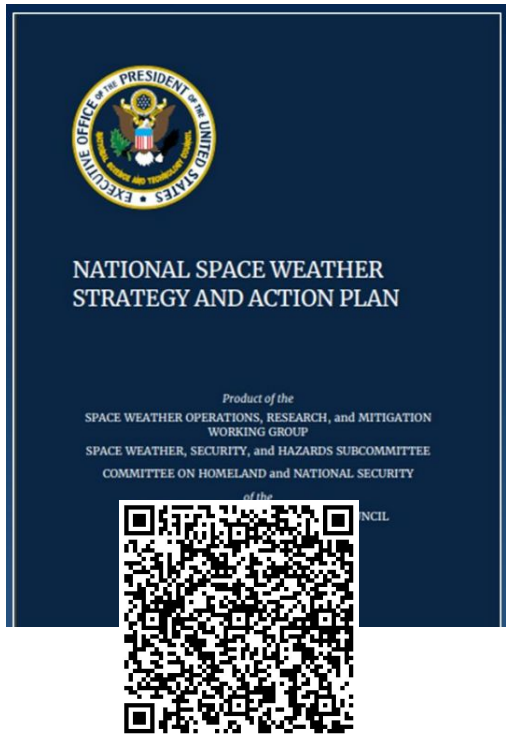
However, still insufficient science and operational capabilities to accurately predict geomagnetic storm intensity

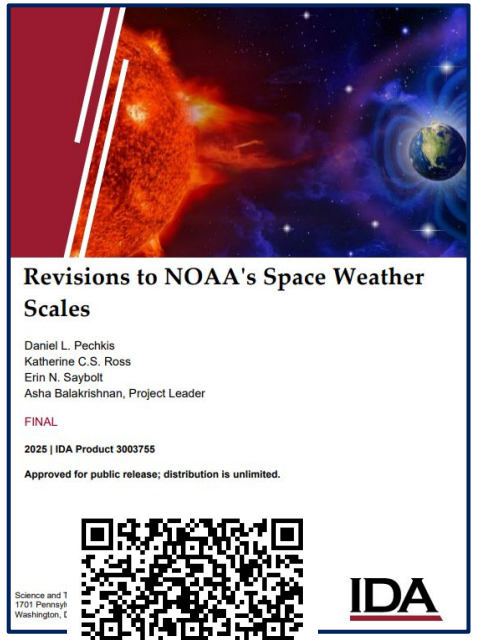
Gannon was a G5, but not a Carrington-class event

- Highlights need to transform Space Weather Scales and Products



Transforming How We Communicate





National Space Weather Strategy and Action Plan: 2.9:
- ***Improve the effectiveness of space weather event notifications.***

SWAG Findings and Recommendations for SWORM: R.15.2.:
- ***Update and expand NOAA space weather scales***

SWAG User Needs: 4.2.4.:
- ***NOAA should develop space weather indices or scales that are relevant for human space flight***

SWAG User Needs

Decadal 3-2:

- ***NOAA should build upon Space Weather Advisory Group surveys ... to document highest-priority customer needs***
- ***Use results to prioritize research goals***

SWORM directing SWAG 2.0 to continue the user-needs effort

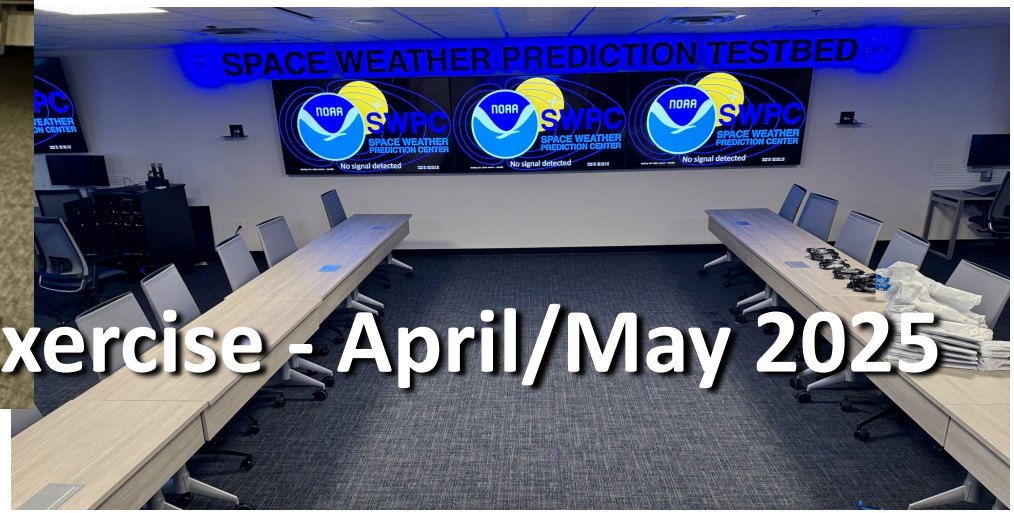
Space Weather Prediction Testbed

National Space Weather Strategy and Action Plan 2.7:

- ***Identify mechanisms for sustaining and transitioning models and observational capabilities from research to operations***

SWAG User Needs 5.9.2:

- ***SWPC should conduct regular testbed exercises and focus groups meetings to determine and further refine specific user requirements***



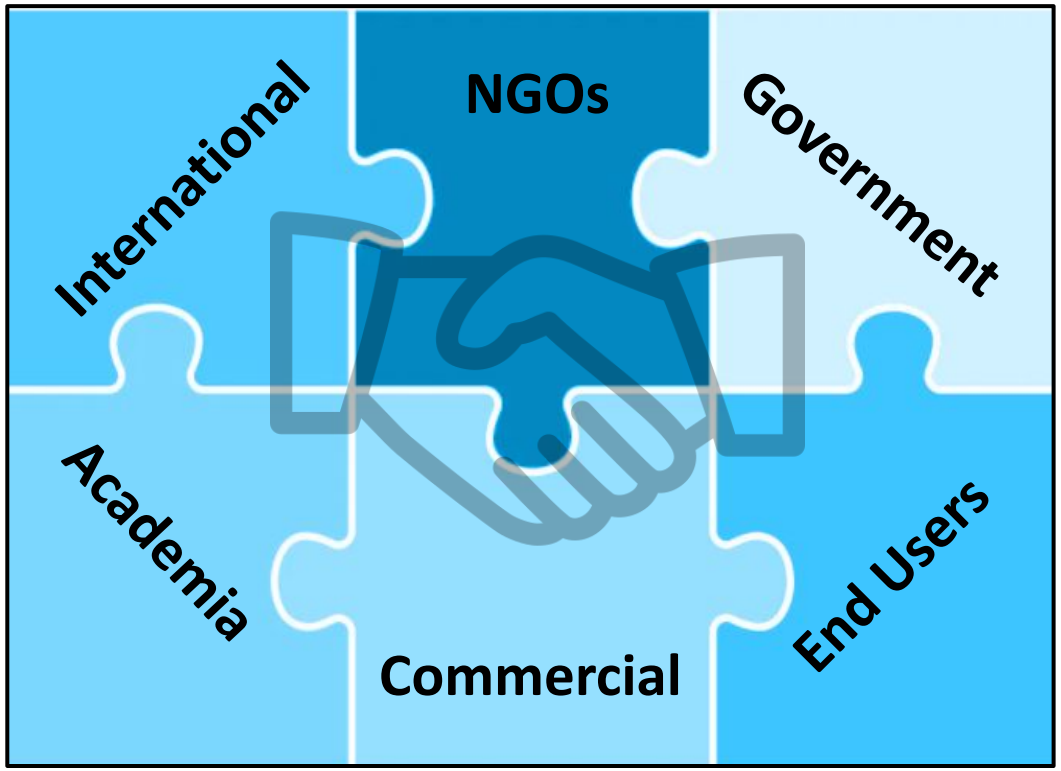
ARTEMIS **Human Space Exploration Testbed Exercise - April/May 2025**

https://testbed.spaceweather.gov/

Toward a Space Weather-Ready Nation

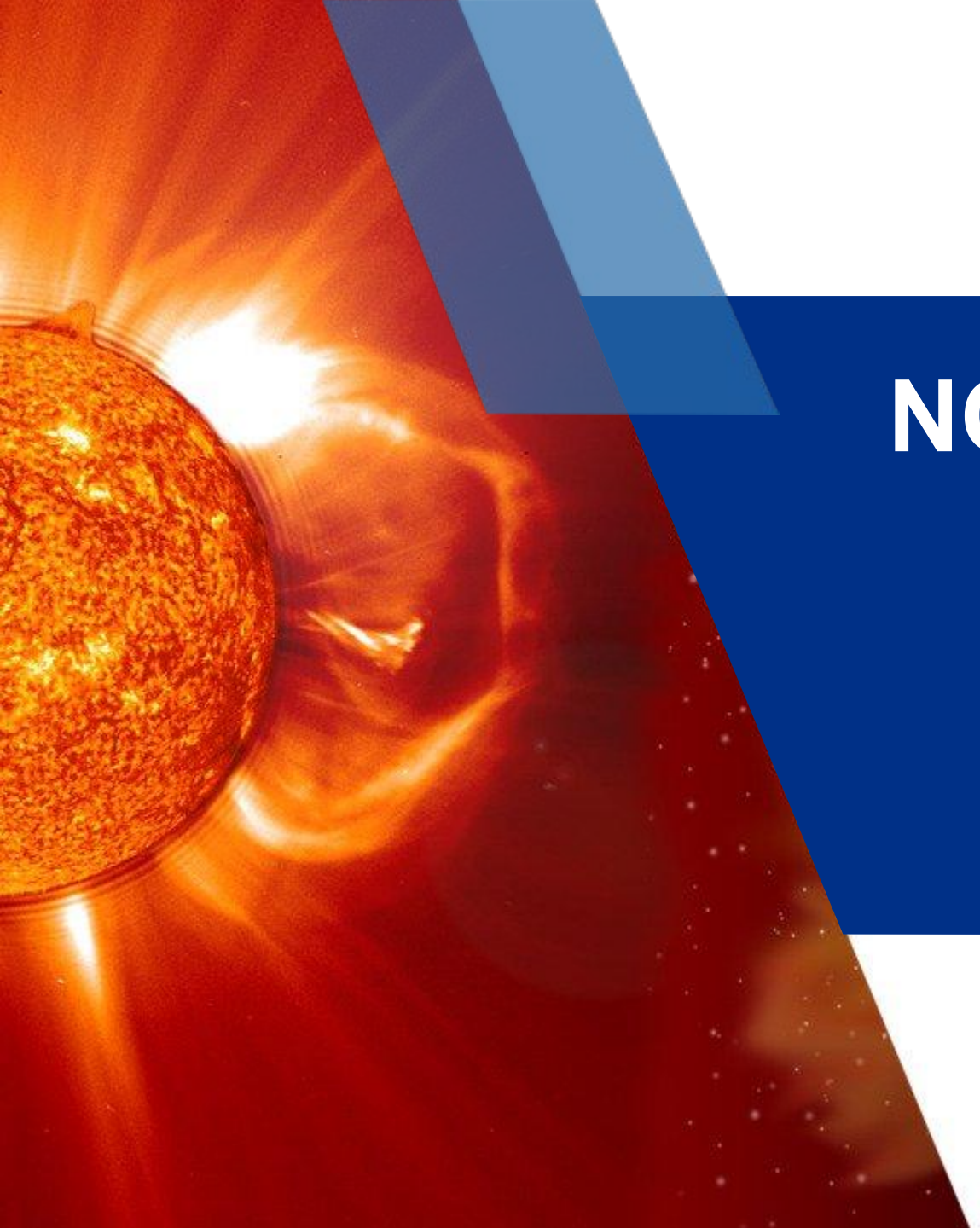
Transform to meet Current and Future Needs of Society

Improve: Infrastructure for Resiliency and Reliability



The Outcome

Protection of Life and Property, Enhancement of the National Economy



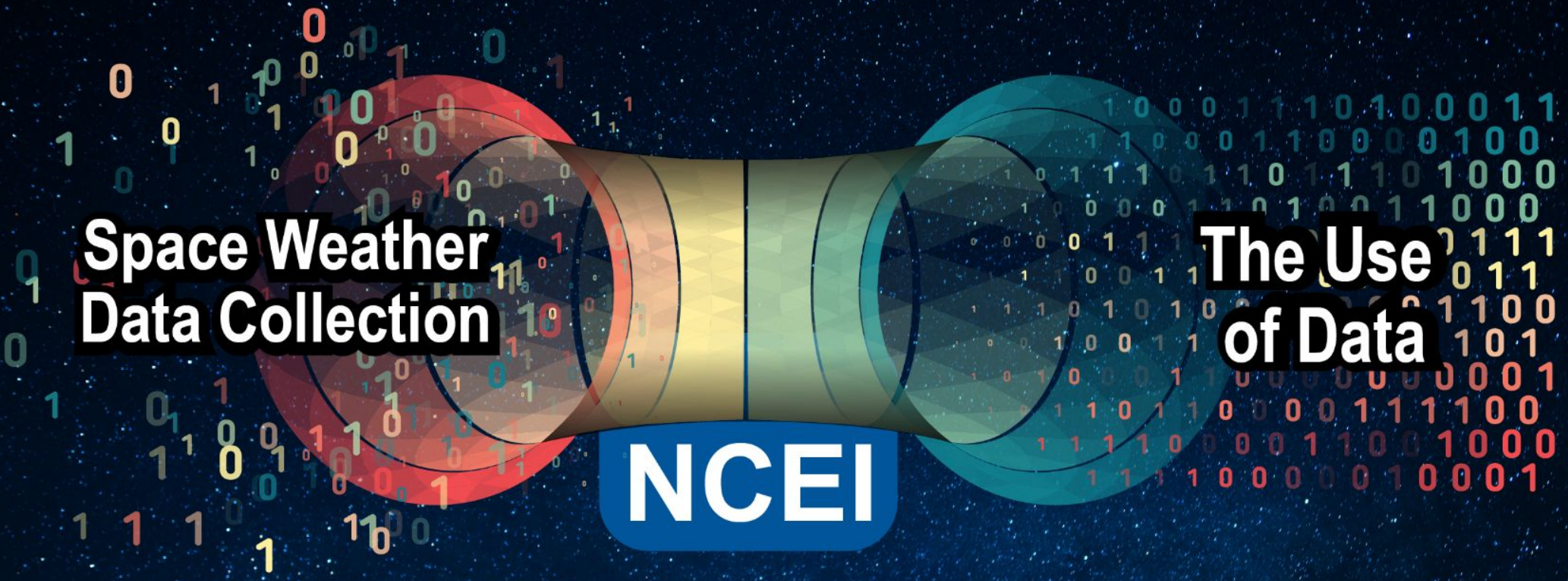
NCEI SWx Products and Services

Presented to CSSP, NASEM Science Week 2025

Dr Laurel Rachmeler, Chief
NCEI Solar and Terrestrial Physics Section

NCEI: Connecting Observations to Outcomes

NCEI is the **interface** between space weather data collection and the use of the data.



As the scientific SWx Subject Matter Experts, **NCEI ensures that data products are accurate and useable** so that NOAA gets value out of its SWx satellite programs and enhances our ability to predict SWx events.

NCEI - SWx Goals

- Improve the scientific quality of NOAA satellite SWx data products.
- Create viable and useful SWx product algorithms for NOAA satellites.
- Ensure NOAA SWx data is archived and accessible.
- Serve both the operational and the scientific communities.

NCEI Algorithms & Cal/Val

- **Algorithms**
  - Developing the NOAA algorithms that turn instrument data into useable products.
  - Heavily involved pre-launch, continued support for scientific enhancements and anomaly support post-operational transition.
- **Calibration & Validation**
  - Data analysis and ground processing algorithm adjustments to ensure that the NOAA SWx data products remain within requirements
  - Cross-calibration with other measurements
  - Deep scientific analysis and research to better understand the measurements and the physical properties
  - Reprocessing of data products to ensure reliable long-baseline measurements for R2O2R applications.

NCEI - NOAA's Archive

NCEI provides environmental data, products, and services covering the depths of the ocean to the surface of the sun to drive resilience, prosperity, and equity for current and future generations.

NCEI's Archives over 60 PB of environmental digitized data, and includes a storehouse of analog records.

The Space Weather archives include NOAA satellite data and most of the other data products hosted by NCEI.

The NCEI digital Archives are in the process of migrating to the NESDIS Common Cloud Environment, with SWFO data being on the forefront of that process.

NCEI - SWx Data Access

- New static product pages are now live at NCEI:
  - https://www.ncei.noaa.gov/products/space-weather/
- Range of data access mechanisms - physical archives in CO and NC, archive request, web accessible folder, dynamic portal
- Continually working to provide better access mechanisms to the most requested and used data:
  - Removing deprecated FTP-only access
  - Easier access to SWPC products, forecasts, etc.
  - New dynamic cloud-based portal starting with SWFO data (next slide)

Coming “Soon”:

NCEI is migrating data stewardship and dissemination tools to the NESDIS Common Cloud Framework (NCCF), starting with SWFO. GOES-R, DSCOVR, and other/future NOAA missions will be migrated afterwards.

- Increase data discovery/accessibility
- Support Research-to-Operations and Operation-to-Research efforts (R2O2R)
- Enable innovative science