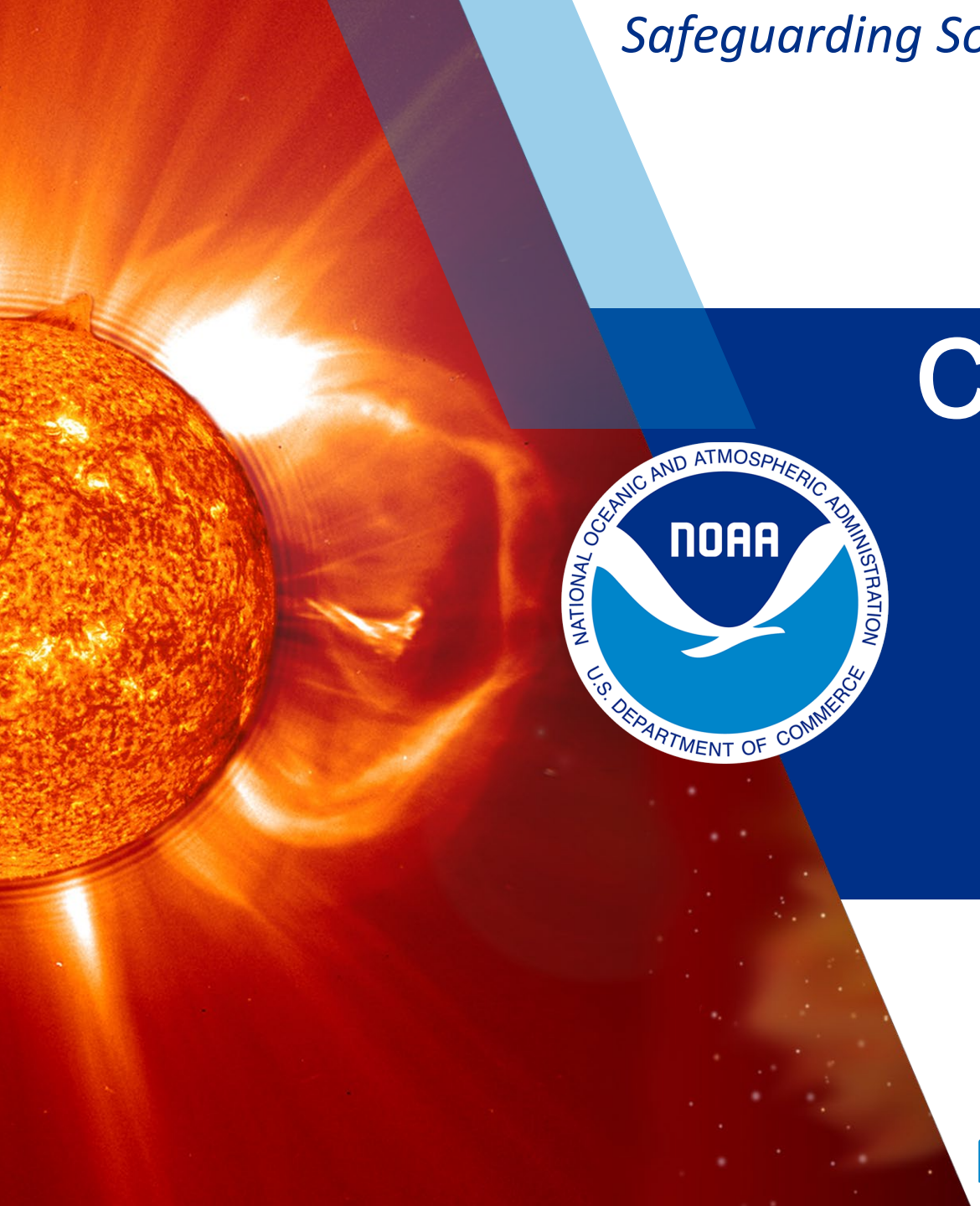
Safeguarding Society with Actionable Space Weather Information



Committee on Solar and Space Physics (CSSP)

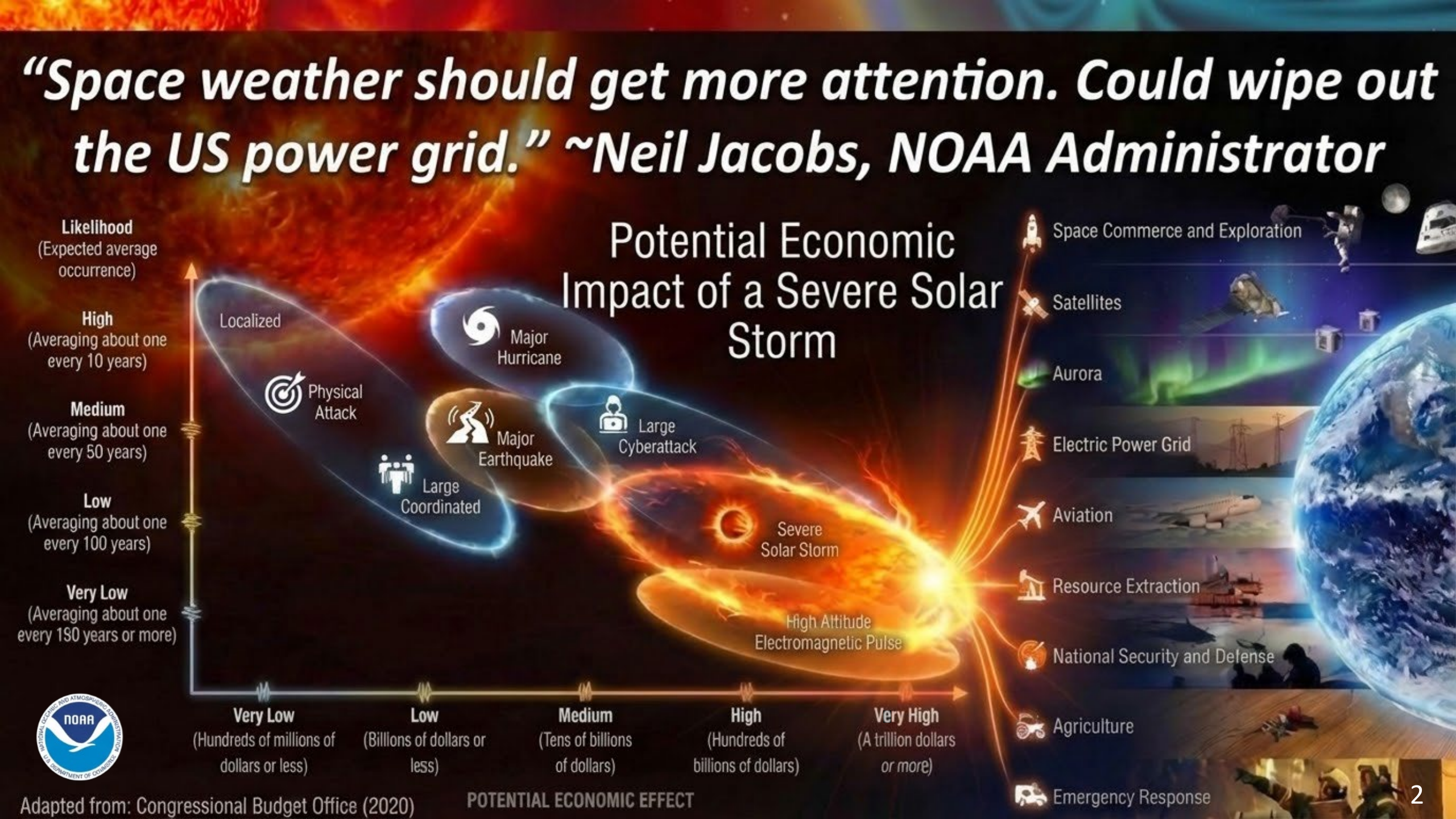
NOAA SWPC Update

March 25, 2026

Clinton Wallace, Director

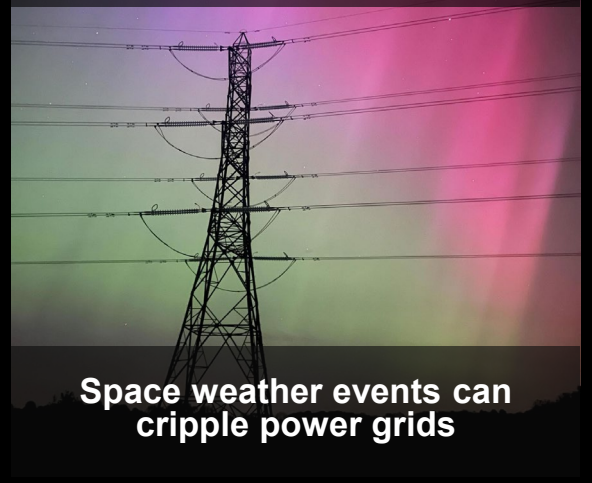
NWS Space Weather Prediction Center

"Space weather should get more attention. Could wipe out the US power grid." ~Neil Jacobs, NOAA Administrator



Adapted from: Congressional Budget Office (2020)

Power Grid



Space weather events can cripple power grids

Astronauts

Radiation in space poses health hazards to astronauts

Satellites

Damaged and degraded spacecraft and orbits

Agriculture

Loss of precision GPS relied upon for planting, crop maintenance, and harvesting

Emergency Management

Cascading effects on critical infrastructure

Autonomous Vehicles

Reduced location accuracy and degraded performance

Aviation

Communication disruption, human health impacts, and avionics damage

National Security

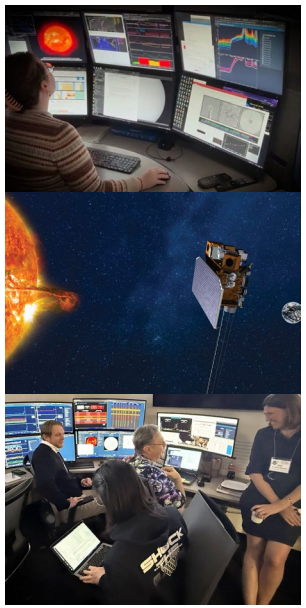
Availability and reliability of national security systems

PROSWIFT (51 U.S.C§60601)

(1D) Clear roles and accountability of Federal departments and agencies are critical for efficient and effective response to threats posed by space weather.

NOAA (2A)

Operational Space Weather



Provides operational space weather monitoring, forecasting, and long-term data archiving and access for **civil applications**

Maintains **ground-based and space-based assets to provide observations** needed for space weather forecasting, prediction, and warnings

Provides research to support operational responsibilities

Develops requirements for space weather forecasting technologies and science

PROSWIFT (51 U.S.C) Authorities

Coordination, Cooperation, & Collaboration (*§60601*)

- SWORM, SWAG, & Nat'l Academies Roundtable

Sustaining & Advancing Observations (*§60603*)

- Continuity of Observations
- GONG, GOES, SOLAR-1
- Space Weather Next

Research-to-Operations-to-Research (*§60604*)

- Space Weather Prediction Testbed
- Probabilistic Modeling and Forecasting
- Data Assimilation

Data Access and Information Sharing (*§60605-07*)

- Commercial Data Program

"It shall be the policy of the United States to prepare and protect against the social and economic impacts of space weather phenomena by supporting actions to improve space weather forecasts and predictions…."

Enabling A Space Weather-Ready Nation

Space Weather Prediction Center Mission

Safeguarding Society with Actionable Space Weather Information

- America's **sole** civilian source of operational space weather warnings and forecasts
- Protects the systems that underpin **national security and daily life**
- Turns observations from the Sun to Earth into **actionable decision support**
- **Accelerates advancement** of operational space weather capabilities

User Needs and Gaps

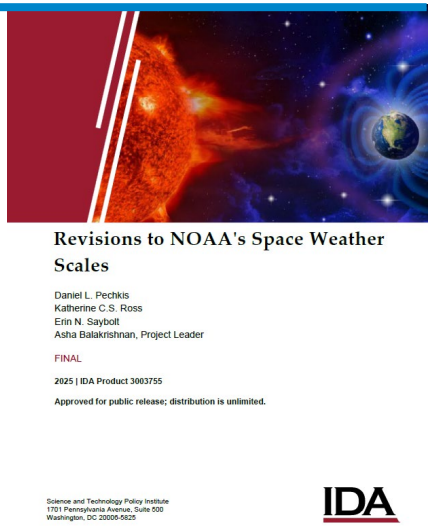
Space Weather Advisory Group

- More usable SWPC products
- More regional, impact based services
- Faster, more automated data
- Testbed driven improvement
- National leadership in observations and modeling

STPI Revisions to NOAA's Space Weather Scales

NOAA scales "do not provide impact information in a way that allows [end-users] to make operational decisions"

"...user communities use the scales differently, and the one-size-fits all approach hampers SWPC's ability to provide high-quality detailed information to audiences that need this level of detail."


Revisions to NOAA's Space Weather Scales

Daniel L. Pechkis
Katherine C.S. Ross
Erin N. Saybolt
Asha Balakrishnan, Project Leader

FINAL

2025 | IDA Product 3003755

Approved for public release; distribution is unlimited.

Science and Technology Policy Institute
1701 Pennsylvania Avenue, Suite 500
Washington, DC 20006-5825

IDA

Space Weather Services Must Transform

Actionable

User-driven

Risk-based

Operations &

Resilience

Advancement

⚠ **The Threat Has Grown**

⚠ **Legacy Capabilities Fall Short**

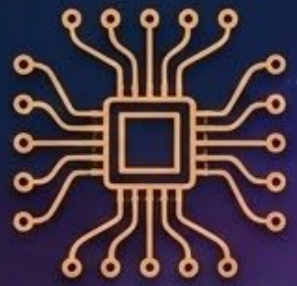
The AURORA Initiative

A 5+ year initiative to transform how we support critical vulnerable sectors

Foundations: AURORA Initiative

Operational Sector Specific Risk Communication

Probabilistic Predictions/ Modeling



Real-time data assimilation

Integrated observational networks

R2O2R Testbed Demonstrations

Social Science

Quad-Agency Space Weather MOA

NOAA
National Oceanic and Atmospheric Administration

NASA
National Aeronautics and Space Administration

NSF
National Science Foundation

DAF
Department of Air Force

- Development of this formal framework was directed by the **PROSWIFT Act**.
- Collaborative effort to improve space weather forecasts and services to mitigate impacts of space weather.
- Addresses a critical gap by providing a formal structure to coordinate the transition of space weather R2O2R

SWPC Collaboration with NASA R2O2R Programs

SWPC seeks benefits through participation with NASA R2O2R Programs

- **Space Weather Centers of Excellence**
  - CLEAR - high energy solar particles
  - SPARTA - ionospheric irregularities
  - SWORD - impacts on Geospace

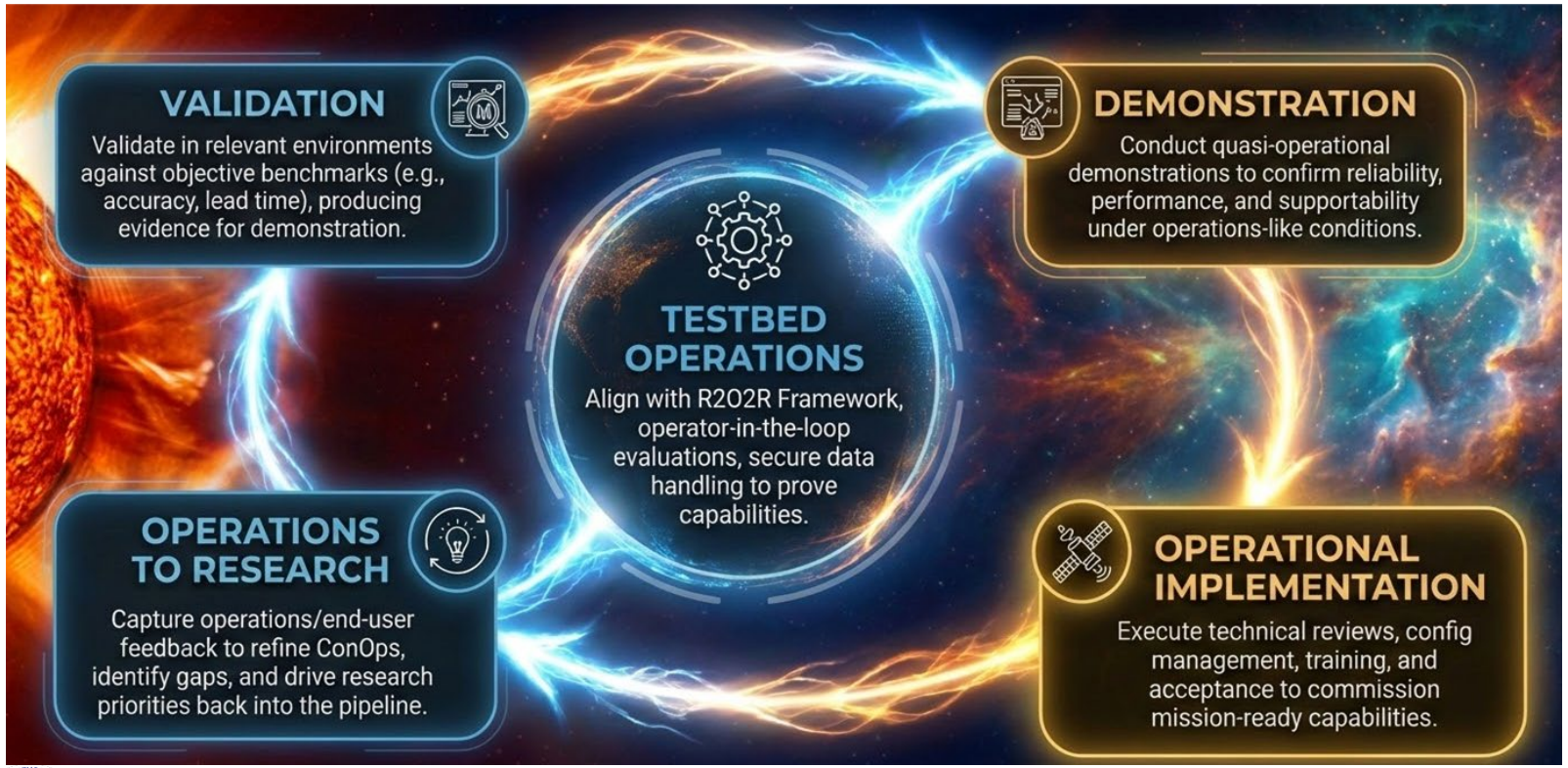
- **ROSES 2025 Space Weather**
  Science Application Research-to-Operations-to-Research

- **NASA DRIVE Center: Center for Geospace Storms**
  (understanding, modeling and predicting geospace storms)

Space Weather Prediction Testbed

Est. 2025

A collaborative operational environment where researchers, developers, forecasters, and end users evaluate and refine new capabilities in real world workflows, accelerating transition into operations and strengthening space weather products and services through direct feedback.



Artemis II Human Spaceflight Testbed Exercise

A mission-integrated exercise that aligned partners, simulated real-time decision making, and accelerated operational improvement for NASA human spaceflight support.

How the exercise worked

Mission -integrated partnerships

Aligned NOAA, NASA, DoD, academia, and industry around Artemis II decision needs.

Displaced real -time simulation

Ran realistic event simulation in a human-in-the-loop operational environment.

Accelerated R2O and enabled O2R

Enabled rapid feedback, iteration, and refinement of space weather capabilities.

Operational Value

- **Extended dedicated SWPC decision support for NASA human spaceflight.**
- **Built on Artemis I lessons learned, refining support practices and procedures.**
- **Improved readiness for time-critical radiation and mission decision support.**
- **Strengthened the NOAA–NASA partnership with clear operational return.**

Why it matters

The exercise validated the Space Weather Prediction Testbed as a practical model for improving mission -time space weather support to NASA human spaceflight.

NOAA Space Weather Support for NASA Human Spaceflight - A Storied Legacy

Central Radio Propagation Lab
National Bureau of Standards
1941

ESSA
Space Disturbance Lab
1965

Space Environment Lab
NOAA Oceanic and Atmospheric Research (OAR)
1970

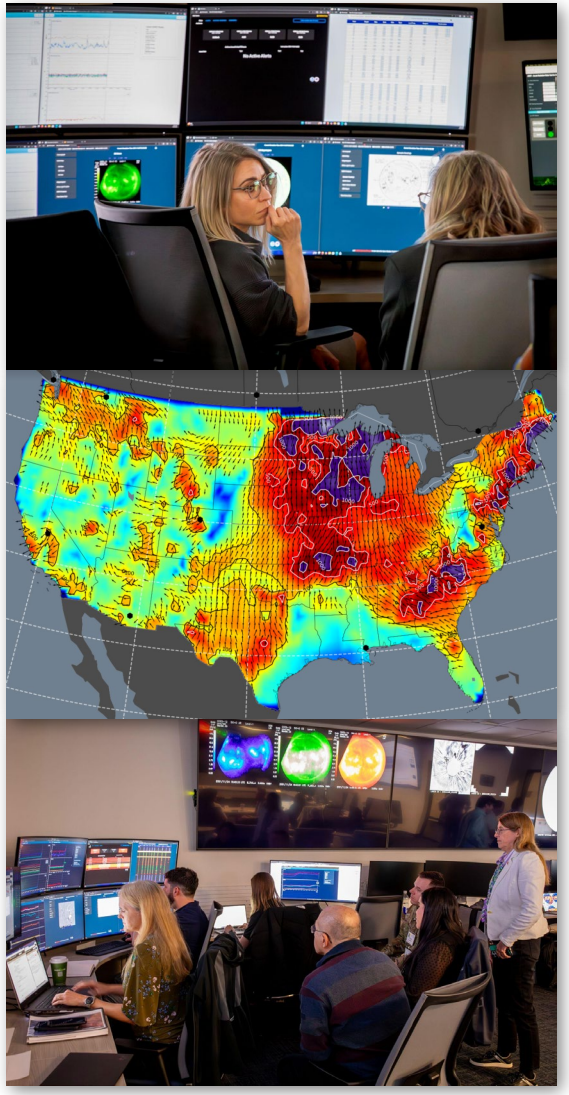
NOAA NWS & OAR
Space Environment Center
1995

Space Weather Prediction Center
NOAA NWS
2005

Mercury • Gemini • Apollo • Skylab • Space Shuttle • ISS • Artemis

Bulk Electric System Space Weather Exercise

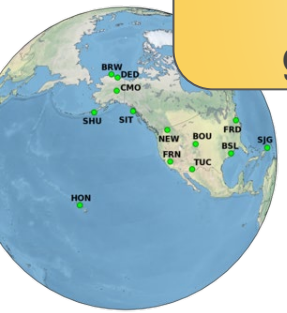
- An exercise simulating a significant geomagnetic storm affecting the U.S. and Canadian Bulk Electric System
- It is a displaced-real-time, operator-in-the-loop evaluation and demonstration
- The goal is to evaluate new decision-support services and risk forecasts
- Tests if modernized space weather services improve decision-making under time pressure
- The 2.5-day in-person exercise is hosted by the Space Weather Prediction Testbed in in August 2026



Critical Ground - and Space-based Observation Capabilities

GONG* – NSF/NSO-NWS
NOAA supports operations

Ground-based Magnetometers – USGS
Critical input to SWPC's geomagnetic storm products



Neutron Monitors – NSF and Academia

Solar Electro-Optical Network (SEON)* – USAF

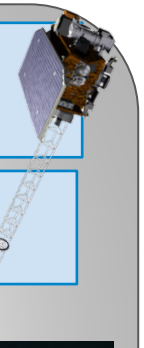
CRITICAL OBSERVATIONS USED IN OPERATIONS

LEO
COSMIC-2*; RO TASA & NOAA; Commercial

GEO
GOES 16-19 – NOAA (GOES-19 w/ CCOR-1)

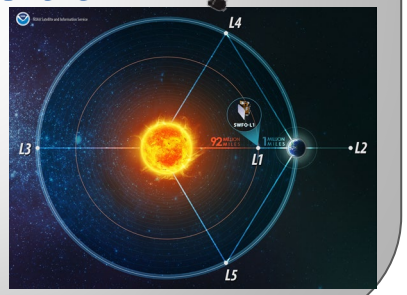
Solar Dynamics Observatory* NASA (Critical Magnetograph)

L1
SWFO-L1 + SOLAR A&B (2029) – NOAA



DSCOVR* – NOAA

Advanced Composition Explorer* – NASA



Solar & Heliospheric Observatory mission (SOHO)* – NASA-ESA

Off-Sun-Earth Line
Vigil L5 (w/ CCOR-3) – ESA (2031)

STEREO-A* – NASA

* asset at risk

Space Weather Strategic Investment Areas

Develop a NOAA Applied Research Program

Establish and develop a NOAA Applied Space Weather Research Program focused on **advancing Space Weather operations**.

Expand Risk-Informed, Sector-Specific Support

Deliver actionable, probabilistic space weather risk guidance and sector specific services that **enable timely, risk informed decisions** across critical infrastructure.

Accelerate Innovation into Operations

Accelerate the transition of innovative capabilities into operations by maturing the **Space Weather Prediction Testbed**, uniting the space weather enterprise and delivering on end-user needs..

Advance Data Assimilation

Exploit increasingly available existing and planned data to enhance predictive excellence, **maximizing ROI on observations** by seamlessly integrating them into models for improved forecasts and decision-making.

Achieve Predictive Excellence Through Advanced Modeling

Upgrade to **advanced physics-based and AI-enabled space weather models** to deliver a community-driven forecasting system that leads to improved accuracy, lead times, and confidence in predicting solar, magnetospheric, and ionospheric disturbances.

Strengthen and Advance Operational Observations

Extend and maintain a sustainable, resilient global network of **ground and space-based sensors** that deliver **real-time, high-fidelity space weather observations** to support actionable decision-making and targeted risk mitigation.

Space Weather Workshop - 2026

Organizer:

CPAESS
Cooperative Programs for the Advancement of Earth System Science

Sponsors:

NOAA, NASA, NSF

Theme: Space Weather & Society: Transforming Services & Science to Meet User Needs

Embassy Suites, Boulder CO, April 27 - May 1 2026

- Organized by User Impact Sector
- Monday Side Meetings (including R2O2R and more), Student Program, Banquet
- To date, more poster abstracts and student applications than ever before
- Registration: https://cpaess.ucar.edu/meetings/2026-space-weather-workshop

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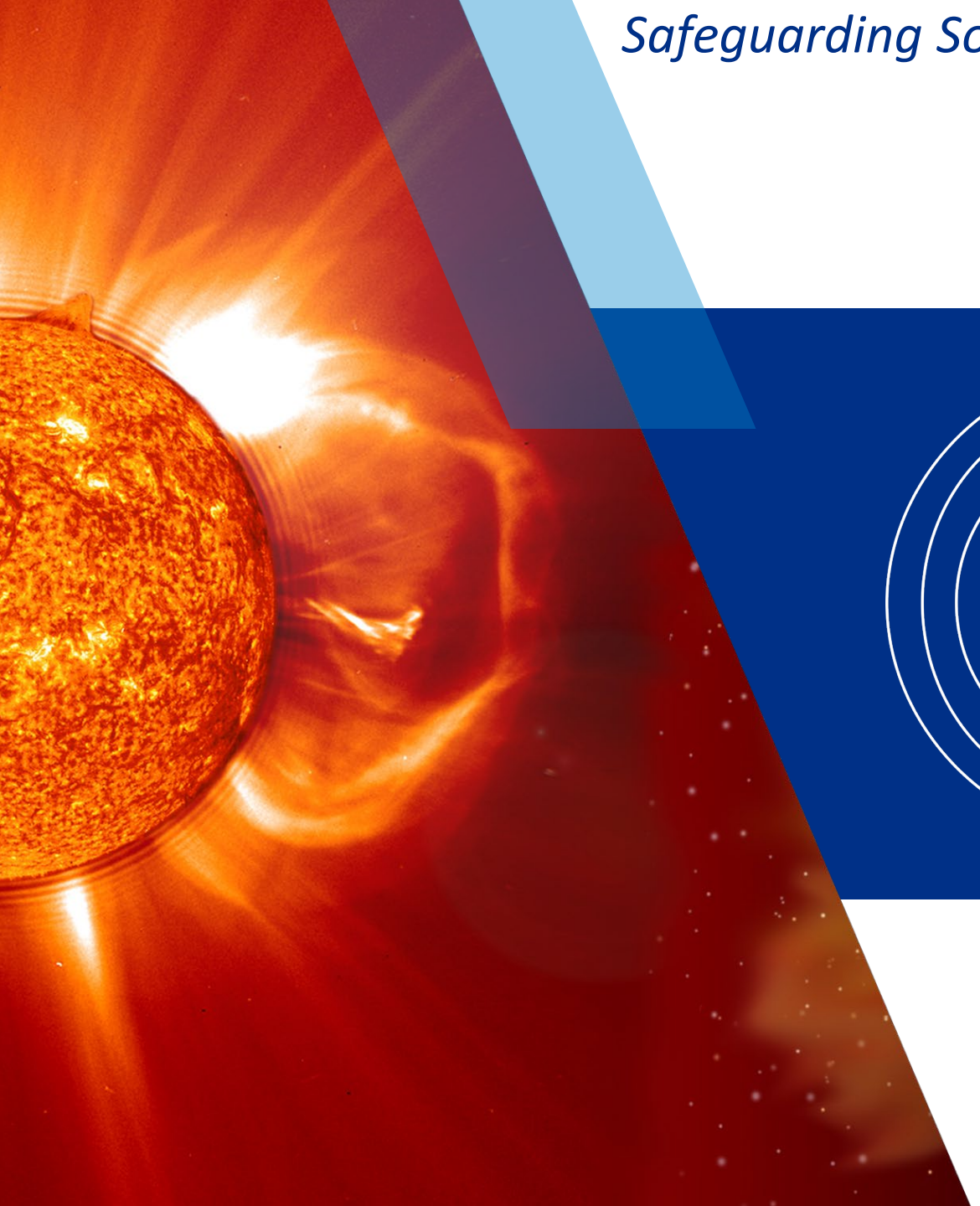

NOAA

SWPC

SPACE WEATHER
PREDICTION CENTER