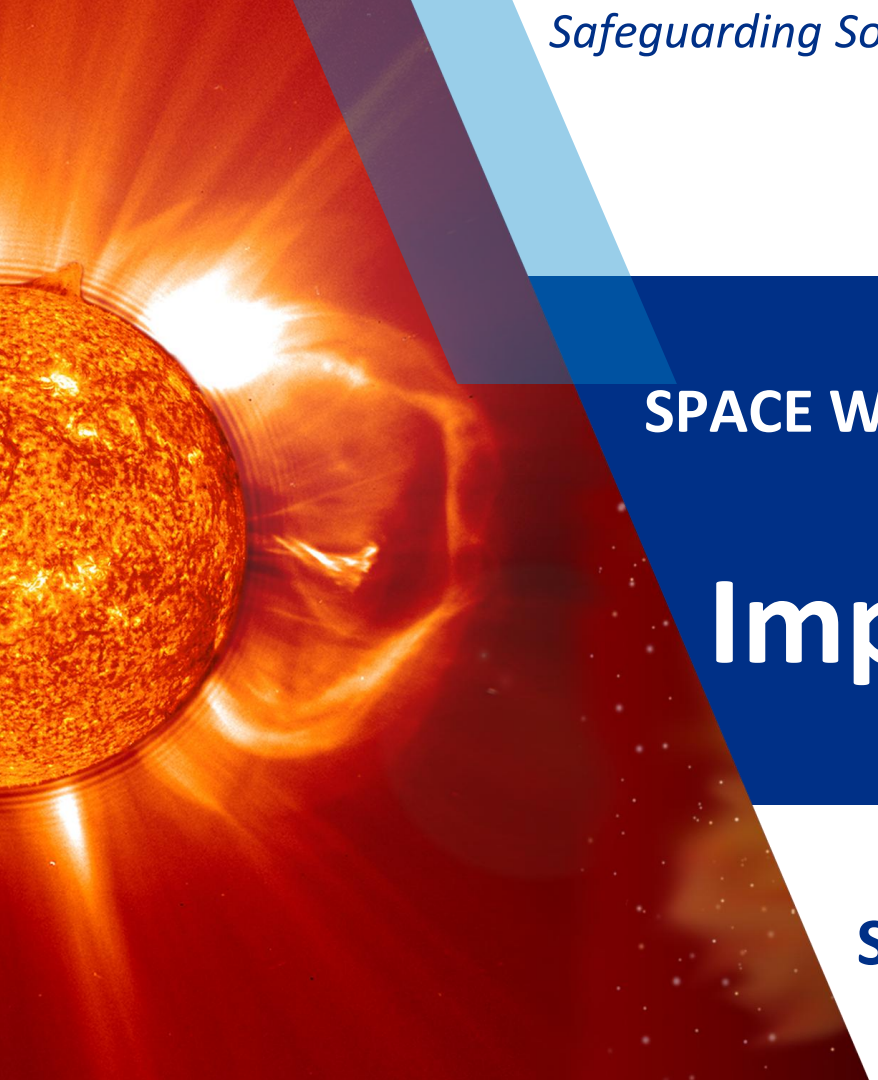
Safeguarding Society with Actionable Space Weather Information



SPACE WEATHER ROUNDTABLE FALL MEETING

SWPC's R2O Implementation Plan

Clinton Wallace, Director

Space Weather Prediction Center

December 4, 2025

Space Weather Strategy Overview

Case for Change

Unfulfilled Mandate | **Unassimilated Observations** | **Unprecedented Vulnerability** | **Underdeveloped & Behind**

Current State

Major elements of the Space Weather Value Chain missing

External research is slow to materialize and Agency missions are not aligned

Space weather is fragmented across NOAA and lacks investment

Staff work disparate functions and mission sets, and lack the time and resources

The Way Forward

Close the gaps along the SWx value chain

Build and develop SWx Workforce

Connect NOAA's SWx groups into a holistic and effective "One-NOAA" SWx cross line office team

Future State

SWx operates as an integrated, properly resourced, end-to-end function

NOAA's applied R&D efforts fuel progress and advance science and technology

SWx capabilities continuously mature through an agile R2O2R process

Our people thrive as they drive mission success

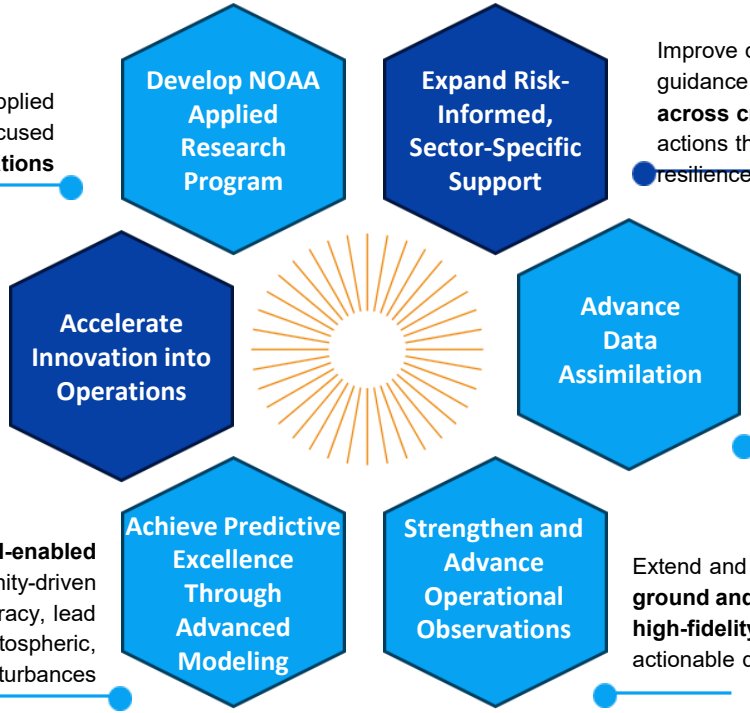
Accelerators

PROSWIFT Act mandate
Advancements in observations
Support across administrations

Barriers

Complacency toward SWx capabilities
Limited workforce development
Long lead times for planning

Strategic Investment Areas



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

Improve delivery of consistent, probabilistic space weather risk guidance and sector-specific services to **empower decision-makers across critical infrastructure sectors** to take timely, risk-informed actions that enhance national preparedness, continuity, and resilience

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

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

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

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

Implementation to Date

Accelerate Innovation into Operations

- FY24/25 built Testbed Facility
- May 2025 Artemis II/Human Spaceflight Exercise
  - Tremendous Partnerships/Success
- 2025 - Implemented internal SWPC transition processes
  - Technical Review Board (TRB)
- Contract for limited transition support
- Dec 1, 2025 - Hired New Federal Testbed Lead - Hazel Bain

More to be covered in Role of the Testbed in the National Space Weather R2O Pipeline at 1:30 PM EST

Testbed Integral to SWPC Transformation

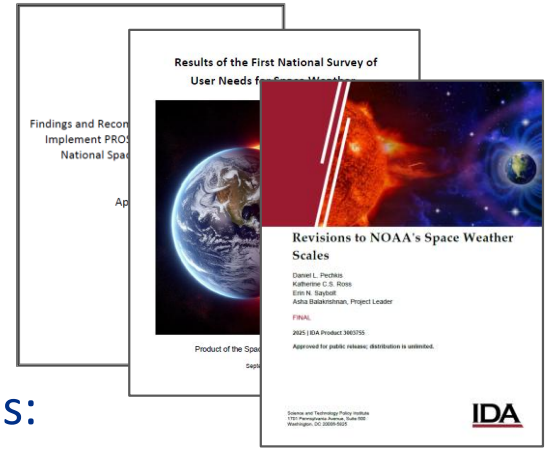
SWPC must transform because America's critical infrastructure is more vulnerable than ever to space weather, and our legacy services are no longer sufficient to meet the Nation's growing operational needs

1. The Threat Has Grown

2. Legacy Capabilities Fall Short

3. It Aligns with the NWS Transformation

User Needs & Gaps



- 2024 National User Needs Survey
  - Overarching Theme 1. Regionalization and Impacts

- STPI Report on Revisions to NOAA Space Weather Scales:
  - NOAA scales “do not provide impact information in a way that allows [end-users] to make operational decisions.”
  - “Another challenge is that user communities use the scales differently, and the one-size-fits-all approach (that includes the general public) hampers SWPC’s ability to provide high-quality detailed information to audiences that need this level of detail.”

- SWAG recommendations:
  Urges NOAA to modernize forecasting, observations, modeling, communication

The AURORA Initiative

Actionable
User-driven
Risk-based
Operations &
Resilience
Advancement

Expand Risk-Informed, Sector-Specific Support

A 5-10 year initiative to transform how SWPC supports critical sectors

Core Objective

Deliver probabilistic, impact-based decision support services (IDSS) that clearly communicate sector-risk, strengthen resilience, and enable a Space Weather-Ready Nation

Core Outcomes – Sector-Specific Services

- **Bulk Electric System**: Regional risk & geoelectric field maps
- **Satellites**: Drag, Charging, Radiation
- **Space flight**: Human Exploration & Launch Support
- **GNSS:** Signal degradation
- **Emergency management**: FEMA-aligned graphics & Plain-Language risk statements
- **Aviation:** Route-specific radiation & HF disruption forecasts

Core Outcomes – Trustworthy Communication

- Revised Scales and Redesigned Visual Tools
- Embedded plain-language preparedness statements
- Multi-format delivery
- User Training, Sector Outreach, Exercises
- Trusted Public-facing communications during events

Foundations: Observations, Assimilation & Models

- Probabilistic ensemble modeling
- Real-time data assimilation
  - Solar Wind, Ionosphere, Geomagnetic, GIC data, Radiation
- Integrated observational networks
  - Space-based, Ground-based
  - Commercial, International
- Testbed Demonstrations
  - Metrics, Validation, Continuous User Feedback

Implementation Roadmap

Phase I (FY26-FY27)

- **Bulk Electric System Services (BES) Transformation**
  - **2026 BES Exercise**
- Space Weather Follow On
- Scales Revisions Implementation
- Artemis II IDSS
- GloTEC with commercial data demonstrated

LIMIT FOCUS
START FAST
LEARN FAST
IMPROVE
REPEAT

Simulated Utilities Response to Geomagnetic Events (SURGE)

- Simulate Bulk Electric System response to geomagnetic storms in a real-time Testbed exercise.
- Validate probabilistic models, regional hazard overlays, and decision support prototypes under time-sensitive, realistic conditions.
- Demonstrate how updated, social science-informed space weather scales effectively communicate risk and enhance operational decision-making for the energy sector.

Implementation Roadmap

Phase II (FY28-FY29)

- Human Space Exploration Transformation
- Satellite Transformation

Phase III (FY30-FY31+)

- Emergency Management Transformation
- Precision Navigation Sector Transformation
- Aviation Transformation

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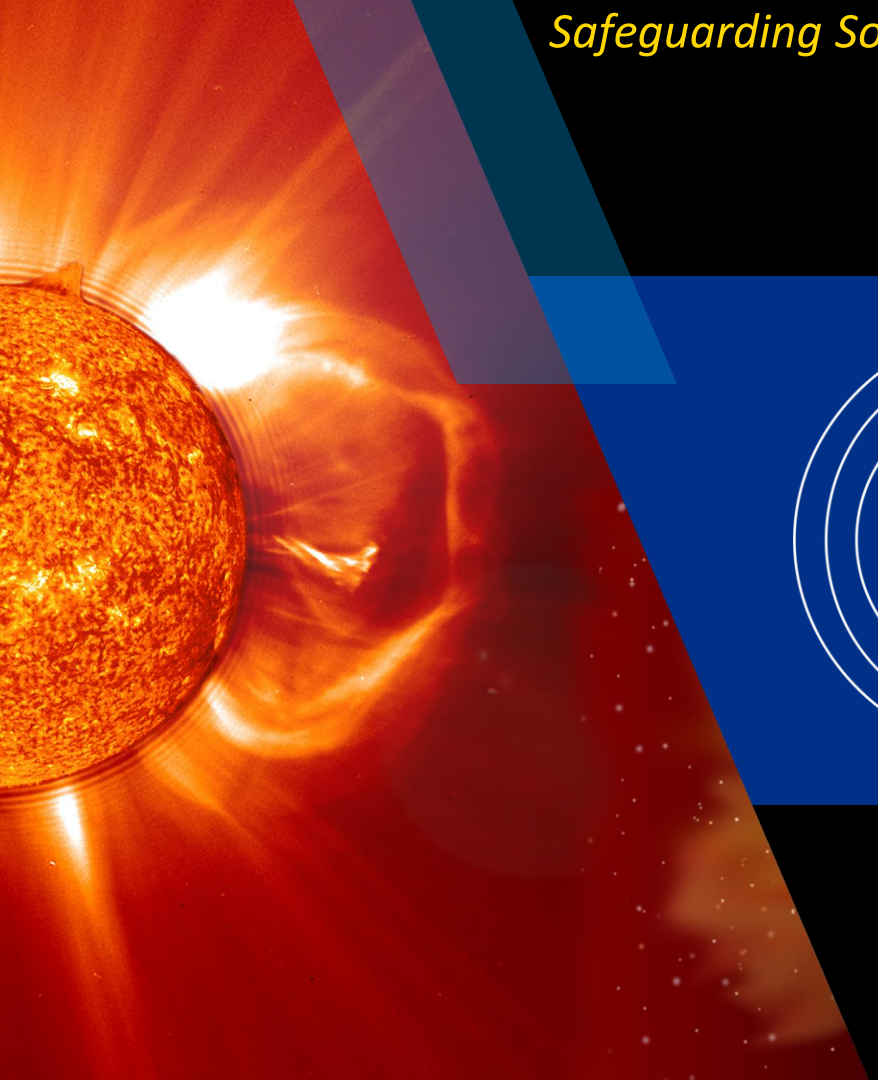

NOAA

SWPC

SPACE WEATHER
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