

Space Weather Observations Summit

National Weather Service Perspective

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Office of Planning and Programming for Service Delivery

White House SWORM Subcommittee



White House Space Weather Operations, Research, and Mitigation (SWORM) Committee

PROSWIFT §60601

34 Federal Departments, Agencies and Offices

Over 100 members



Co-Chairs

OSTP, Assistant Director of Space Policy

NOAA, Assistant Administrator for Weather Services

DHS, Assistant Director, National Risk Management Center

Objective 1

Lead by: DHS & DOD

Enhance the Protection of National Security, Homeland Security, and Commercial Assets and Operations against the Effects of Space Weather

Objective II

Lead by: NOAA & NASA

Develop and Disseminate Accurate and Timely Space Weather Characterization and Forecasts

Objective III

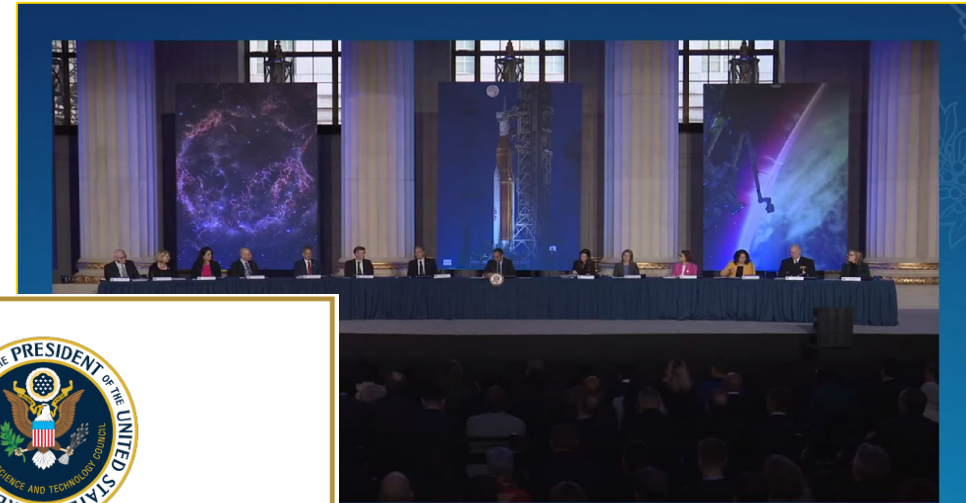
Lead by: FEMA & NOAA

Establish Plans and Procedures for Responding to and Recovering from Space Weather Events

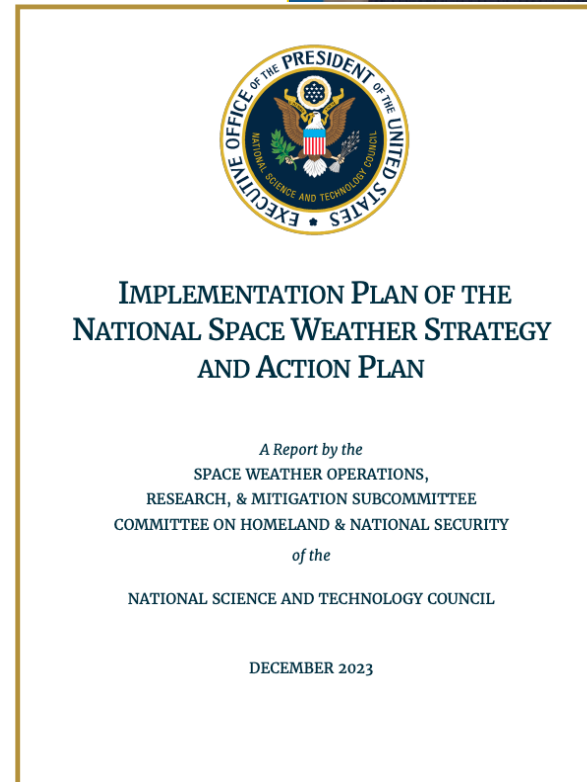


NWS responding to the new Implementation Plan (IP)

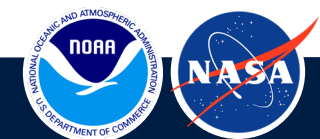
- Released Dec 2023 by the National Space Council
- 93 Total Actions



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NOAA's Six Critical Societal Challenges

1. Extreme Events and Cascading Hazards
2. Coastal Resilience
3. The Changing Ocean
4. Water Availability, Quality, and Risk
5. **Effects of Space Weather**
6. Monitoring & Modeling for Climate Change Mitigation

SPACE
WEATHER
SOCIETAL
OUTCOMES

- Safeguard communication systems**
- Space Weather Threat and Mitigation Education**
- New region-specific space weather products and services**
- Space traffic coordination/Nascent space economy**

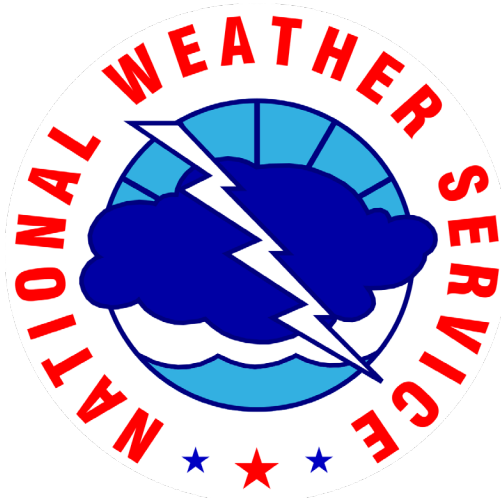




Meeting current and future needs of society

Impact Decision Support Services (IDSS)

- Serve Decision Makers
- Communicate risk-based/probabilistic information
- Enable new, innovative, sustainable, and high-impact products and services



Space Weather Prediction Testbed

- Accelerate the transition of advanced cutting-edge capabilities into our operations.
- Fast-track space weather Enterprise innovations and technology
- R2O2R Agreement with NOAA, NASA, NSF, Dept of Air Force

Social, Behavioral, and Economic Science

- Understand societal needs to design products and services that attain the desired response to high impact events



Space Weather Prediction Center

The official source of space weather decision support services, forecasts, watches, and warnings, and alerts for the United States

“Safeguarding Society with Actionable Space Weather Information”

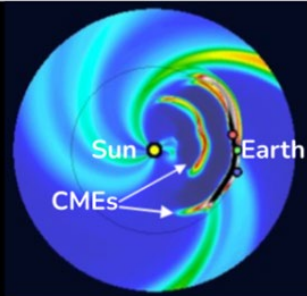
G5 Conditions Observed

Updated 2024-May-10 1930 EDT

WHAT: First Observed G5 Since October 2003

KEY MESSAGES: EXTREME (G5) conditions reached Earth at 6:54 pm EDT. Geomagnetic storming is likely to persist through the weekend as several additional Earth-directed Coronal Mass Ejections (CMEs) are in transit.

IMPACTS: HF/VHF/UHF communications, GPS, power grids, spacecraft, satellite navigation, and other technologies may be affected. *Some have been notified.*



...rred with the Halloween
...in power outages in
...Africa.

...complex sunspot
...the diameter of Earth.
...pected.

...Actionable Space Weather Information
Space Weather Prediction Center,
Boulder, CO

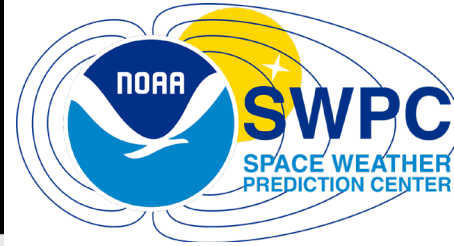


Image Credit: USA Today

www.SpaceWeather.gov



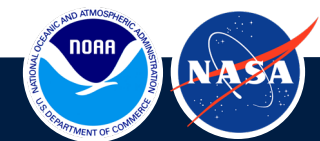
Quad MOA to implement R2O2R framework signed!

NSW-SAP IP Action 2.7.2

- Interagency Agreement between Dept of Air Force, NSF, NASA, and NOAA
- Meet Agency PROSWIFT Act Obligations
- To encourage and support interagency collaboration
- Advance the Nation's space weather R2O2R capabilities
- December 2023



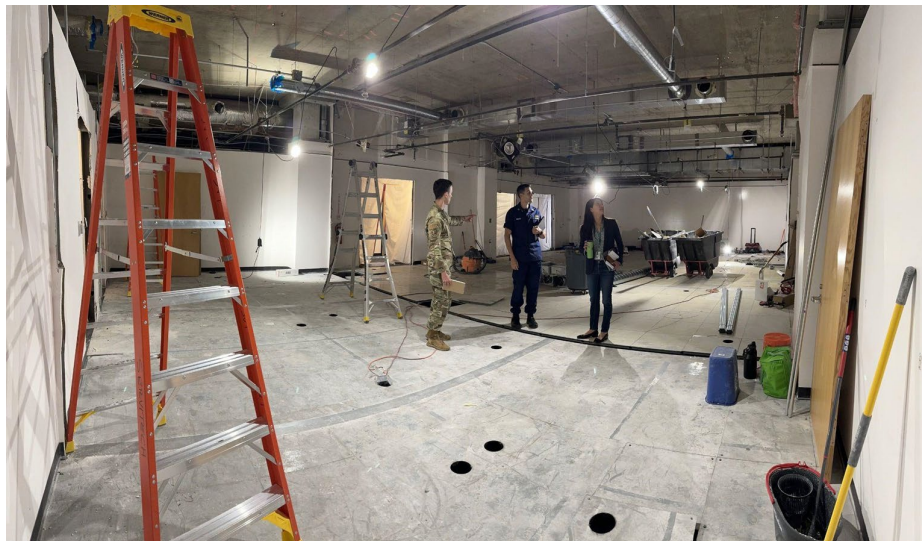
News story links: [Spacenews](#), [NOAA](#), [NASA](#)





Space Weather Prediction Testbed (SWPT)

- A key component of the formal R2O2R Framework
- Demonstrated initial success in testbed exercises with Aviation industry (2022) and Satellite industry (2023)
- **Buildout of the testbed facility has begun!**

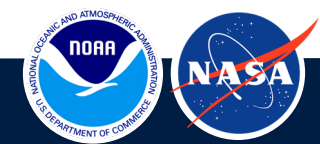
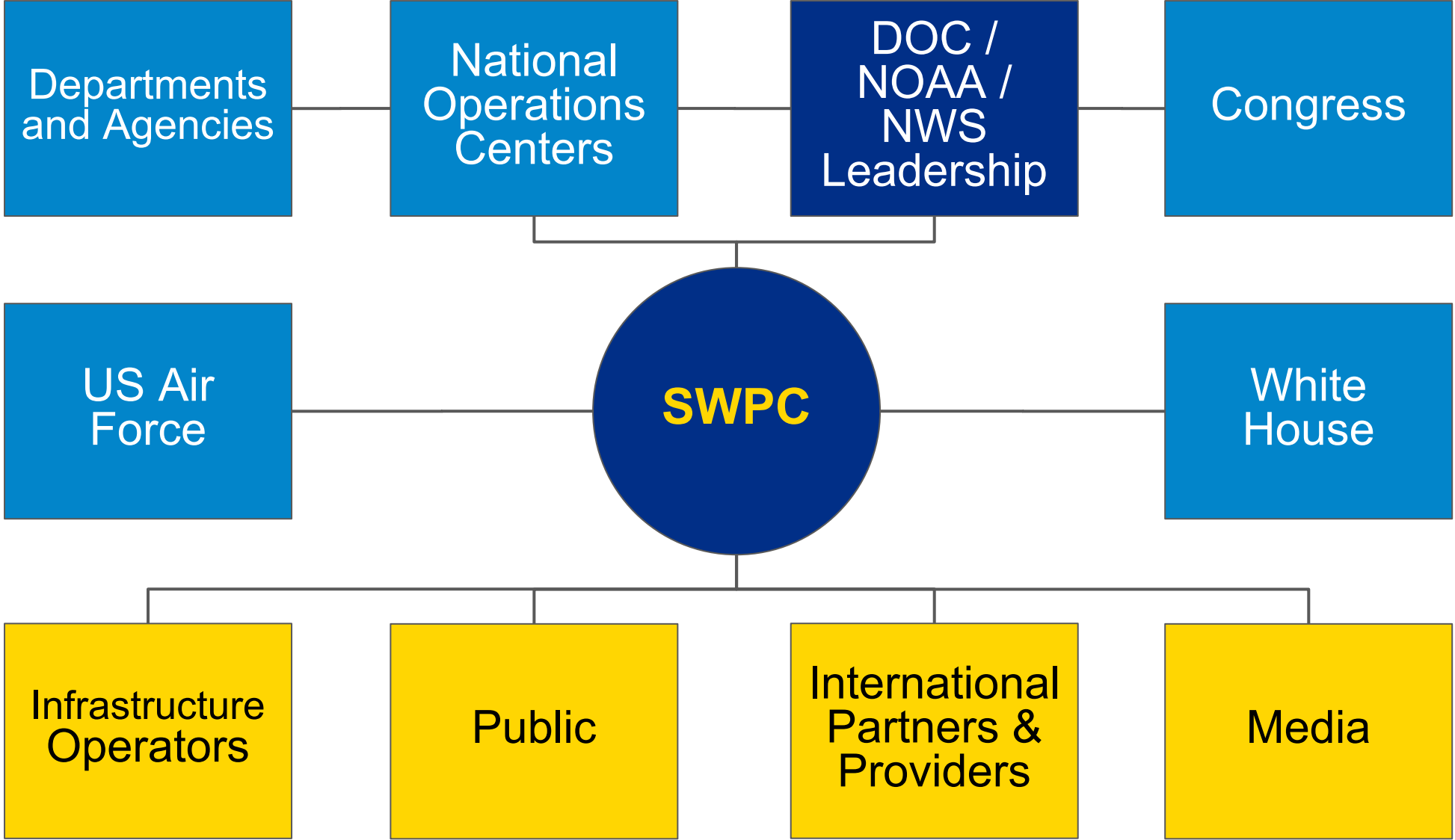


Testbed exercise with satellite industry held in Boulder, CO



Communication Effectiveness

- Engage international partners to **ensure space weather products and services are globally coordinated and consistent**, as appropriate, during extreme events (Actions 2.10.1-2.10.3)
- **Improve public awareness, education, and engagement** regarding space weather and its effects. Develop a strategy to promote societal awareness of space weather (Action 3.2.1-3.2.2)
- Improve the effectiveness of **space weather event notifications** (NSW-SAP IP Actions 2.9.1-2.9.4)

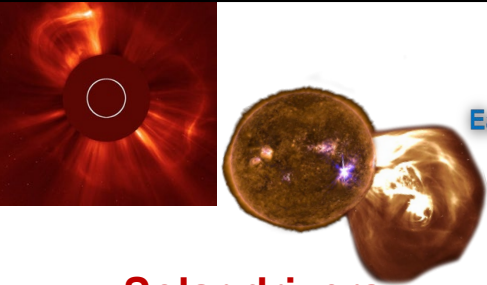
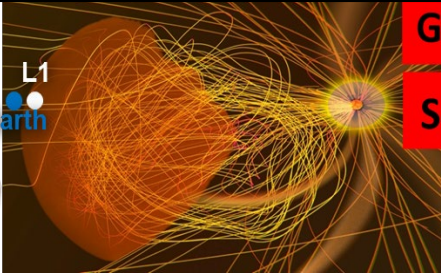
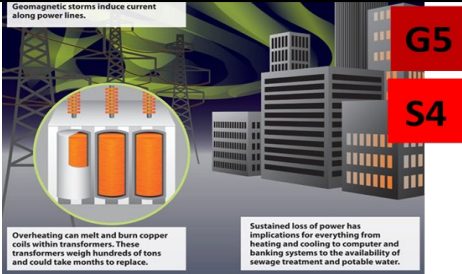
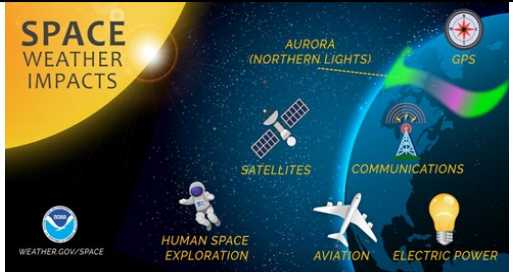




US National Space Weather Exercise

Exercised federal response, recovery, and operations plans and procedures for space weather events

- First Federal and Regional/State Government exercise on 8-9 May 2024
- Included NOAA, NASA, FEMA, Dep. of Energy, Defense, State, Homeland Security, and more
- Much more still needs to be done to fully engage emergency planners at state and local levels
- Explored many challenges including information sharing; astronaut safety; degraded communications, navigation, and power services; and briefly touch on national security concerns

Module 0	Module 1	Module 2	Module 3	Module 4
<p>Introduction to Space Weather</p> <p>Other relevant educational and awareness sessions for Senior Leaders</p>	<p>Scenario</p>  <p>Solar drivers</p>	 <p>G4 S4</p> <p>Radiation Storm Geomagnetic storm</p>	 <p>G5 S4</p> <p>Extreme geomagnetic storm</p>	 <p>Response and recovery</p>

Space Weather Scales

Update and expand, as appropriate, the NOAA space weather scales

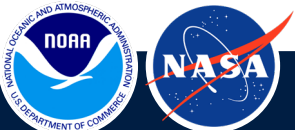
- Unchanged since 1999, Scales are used worldwide to initiate hazard preparedness and mitigation operations
- Space weather capabilities, user base, and user needs have grown and changed dramatically over the last 25 years
- Major 2+ year project to update the scales



NOAA Space Weather Scales



Category		Effect	Physical measure	Average Frequency (1 cycle = 11 years)
Scale	Descriptor	Duration of event will influence severity of effects		
Geomagnetic Storms				
			Kp values* determined every 3 hours	Number of storm events when Kp level was met; (number of storm days)
G 5	Extreme	<p>Power systems: widespread voltage control problems and protective system problems can occur, some grid systems may experience complete collapse or blackouts. Transformers may experience damage.</p> <p>Spacecraft operations: may experience extensive surface charging, problems with orientation, uplink/downlink and tracking satellites.</p> <p>Other systems: pipeline currents can reach hundreds of amps, HF (high frequency) radio propagation may be impossible in many areas for one to two days, satellite navigation may be degraded for days, low-frequency radio navigation can be out for hours, and aurora has been seen as low as Florida and southern Texas (typically 40° geomagnetic lat.).**</p>	Kp=9	4 per cycle (4 days per cycle)
G 4	Severe	<p>Power systems: possible widespread voltage control problems and some protective systems will mistakenly trip out key assets from the grid.</p> <p>Spacecraft operations: may experience surface charging and tracking problems, corrections may be needed for orientation problems.</p> <p>Other systems: induced pipeline currents affect preventive measures, HF radio propagation sporadic, satellite navigation degraded for hours, low-frequency radio navigation disrupted, and aurora has been seen as low as Alabama and northern California (typically 45° geomagnetic lat.).**</p>	Kp=8	100 per cycle (60 days per cycle)
G 3	Strong	<p>Power systems: voltage corrections may be required, false alarms triggered on some protection devices.</p> <p>Spacecraft operations: surface charging may occur on satellite components, drag may increase on low-Earth-orbit satellites, and corrections may be needed for orientation problems.</p> <p>Other systems: intermittent satellite navigation and low-frequency radio navigation problems may occur, HF radio may be intermittent, and aurora has been seen as low as Illinois and Oregon (typically 50° geomagnetic lat.).**</p>	Kp=7	200 per cycle (130 days per cycle)
G 2	Moderate	<p>Power systems: high-latitude power systems may experience voltage alarms, long-duration storms may cause transformer damage.</p> <p>Spacecraft operations: corrective actions to orientation may be required by ground control; possible changes in drag affect orbit predictions.</p> <p>Other systems: HF radio propagation can fade at higher latitudes, and aurora has been seen as low as New York and Idaho (typically 55° geomagnetic lat.).**</p>	Kp=6	600 per cycle (360 days per cycle)
G 1	Minor	<p>Power systems: weak power grid fluctuations can occur.</p> <p>Spacecraft operations: minor impact on satellite operations possible.</p> <p>Other systems: migratory animals are affected at this and higher levels; aurora is commonly visible at high latitudes (northern Michigan and Maine).**</p>	Kp=5	1700 per cycle (900 days per cycle)





Why we need to change the Space Weather Scales

G5 Geomagnetic Storm on 10-11 May, 2024

G5 Geomagnetic Storm on 1-2 Sep, 1859 (Carrington)

- Both storm categorized as G5, but differ greatly in intensity
- May 2024 G5 not a superstorm, Carrington very much was!

Solar Flare Radio Blackout on 14 Dec 2023 - R3

- Focuses on HF degradation but misses VHF

Observation Capabilities: The backbone of all space weather services



GONG – NSF/NSO
NOAA now supporting operations

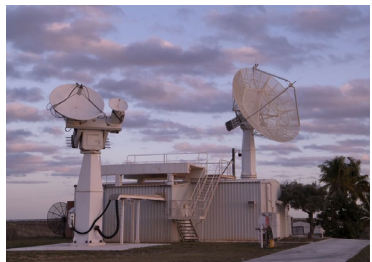
DSCOVR – NOAA

GOES – NOAA
GOES U - NRL
Coronagraph in 2024



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 FOR OPERATIONS

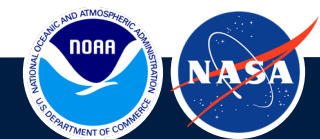
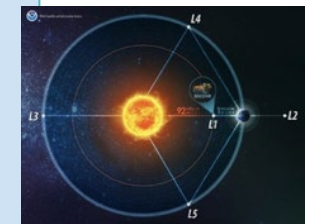
Solar Dynamics Observatory – NASA

Advanced Composition Explorer – NASA

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

Vigil L5 (Future) – ESA (TBD)

Space Weather Follow-On (Future) – NOAA
Rideshare to L1 with NASA's IMAP in 2025





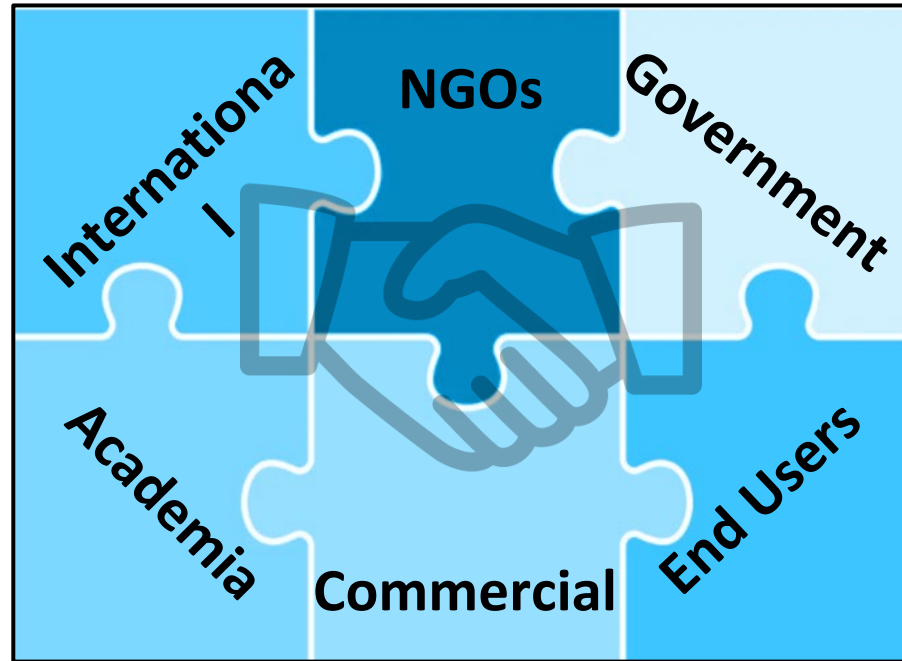
A SPACE WEATHER READY NATION

Requires critical public-private collaborations between the Federal Government, Industry, Academia, and International Partners

People As Top Priority—Always!

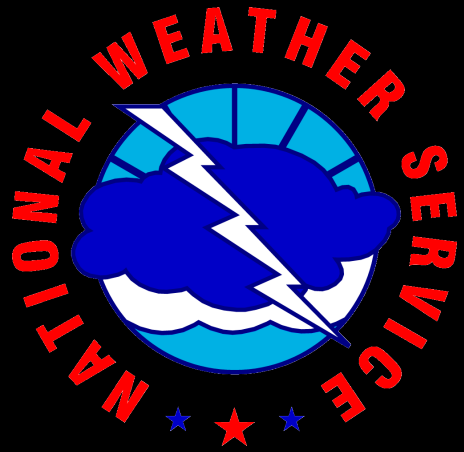


Transform the NWS to meet Current and Future Needs of Society



Improve Our Infrastructure to be Resilient and Reliable

The Outcome
The Protection of Life and Property and the Enhancement of the National Economy



Thank you!

