IMPLEMENTATION PLAN OF THE NATIONAL SPACE WEATHER STRATEGY AND ACTION PLAN

A Report by the

SPACE WEATHER OPERATIONS,
RESEARCH, & MITIGATION SUBCOMMITTEE
COMMITTEE ON HOMELAND & NATIONAL SECURITY

of the

NATIONAL SCIENCE AND TECHNOLOGY COUNCIL

DECEMBER 2023

About the Office of Science and Technology Policy

The Office of Science and Technology Policy (OSTP) was established by the National Science and Technology Policy, Organization, and Priorities Act of 1976 to provide the President and others within the Executive Office of the President with advice on the scientific, engineering, and technological aspects of the economy, security, health, foreign relations, and the environment. OSTP leads interagency science and technology policy coordination efforts, assists the Office of Management and Budget with an annual review and analysis of federal research and development in budgets, and serves as a source of scientific and technological analysis and judgment for the President with respect to major policies, plans, and programs of the federal government. More information is available at http://www.whitehouse.gov/ostp.

About the National Science and Technology Council

The National Science and Technology Council (NSTC) is the principal means by which the Executive Branch coordinates science and technology policy across the diverse entities that make up the federal research and development enterprise. A primary objective of the NSTC is to ensure that science and technology policy decisions and programs are consistent with the President's stated goals. The NSTC prepares research and development strategies that are coordinated across federal agencies aimed at accomplishing multiple national goals. The work of the NSTC is organized under committees that oversee subcommittees and working groups focused on different aspects of science and technology. More information is available at http://www.whitehouse.gov/ostp/nstc.

About the NSTC Subcommittee on the Space Weather Operations, Research, and Mitigation

The Space Weather Operations, Research, and Mitigation (SWORM) Subcommittee is organized under NSTC Committee on Homeland and National Security. The SWORM Subcommittee seeks to coordinate federal government departments and agencies to enhance national capabilities in promoting resilience to the effects of space weather.

About this Document

The SWORM Subcommittee developed the Implementation Plan of the National Space Weather Strategy and Action Plan. The SWORM Subcommittee considered and incorporated, as appropriate, input from key stakeholders including the Space Weather Advisory Group.

Disclaimer

Reference in this document to any specific commercial product, process, service, manufacturer, company, or trademark is to provide clarity and does not constitute its endorsement or recommendation by the United States Government.

Copyright Information

NATIONAL SCIENCE AND TECHNOLOGY COUNCIL

Chair

Arati Prabhakar, Assistant to the President for Science and Technology, and Director, Office of Science and Technology Policy

Executive Director (Acting)

Kei Koizumi, Principal Deputy Director for Policy, Office of Science and Technology Policy

SPACE WEATHER OPERATIONS, RESEARCH, AND MITIGATION SUBCOMMITTEE

Co-Chairs

Ezinne Uzo-Okoro, Office of Science and Technology Policy

Kenneth Graham, Department of Commerce, National Oceanic and Atmospheric Administration

Mona Harrington, Department of Homeland Security, Cybersecurity and Infrastructure Security Agency

Executive Secretary

Jennifer Meehan, Department of Commerce, National Oceanic and Atmospheric Administration

Members

Departments
Department of Commerce
Department of Defense
Department of Energy
Department of Homeland Security
Department of the Interior
Department of State
Department of Transportation

Executive Office of the President
National Security Council
National Space Council
Office of Management and Budget

Agencies
Environmental Protection Agency
Federal Communications Commission
Federal Emergency Management Agency
Federal Energy Regulatory Commission
National Aeronautics and Space Administration
National Science Foundation
Nuclear Regulatory Commission

Table of Contents

Introduction

The Biden-Harris Administration has made it a space policy priority to strengthen the security and resilience of space systems that support U.S. critical infrastructure. Space weather is a naturally occurring phenomenon that has the potential to cause adverse effects on the nation's critical functions and operational systems in space and on Earth. Extreme space weather events, including solar flares and coronal mass ejections—when the sun expels plasma and magnetic fields—can disrupt or disable electric power, communications, water supply, health care, satellite operations, and transportation. The United States must be able to forecast and prepare for space weather events that pose significant risk to U.S. national security and the economy.

The 2015 National Space Weather Strategy and Action Plan set the foundation for a whole-of-government approach to space weather, elevating the issue across the federal government. The plan catalyzed efforts to enhance research and development, improve operational capabilities, and strengthen partnerships with the commercial sector, academia, and the international community. Building on this, the Space Weather Operations, Research, and Mitigation (SWORM) Subcommittee developed a revised National Space Weather Strategy and Action Plan in 2019, which aligned ongoing and future space weather activities under three main objectives:

1. Enhance the Protection of National Security, Homeland Security, and Commercial Assets and Operations against the Effects of Space Weather,
2. Develop and Disseminate Accurate and Timely Space Weather Characterization and Forecasts; and
3. Establish Plans and Procedures for Responding to and Recovering from Space Weather Events.

This 2023 Implementation Plan incorporates progress[1] on these activities and serves as a roadmap for coordinated interagency efforts. This Implementation Plan identifies actions to implement the 2019 National Space Weather Strategy and Action Plan over the next five years.

This Implementation Plan is intended to inform the policy development process. It also incorporates activities outlined in Public Law 116 - 181, Promoting Research and Observations of Space Weather to Improve the Forecasting of Tomorrow Act (PROSWIFT Act). Any commitment of federal resources to support the activities outlined in this document will be determined through the budget process. Strong coordination and collaboration across federal agencies, the Space Weather Advisory Group, the academic community, the private sector, and international allies and partners will improve the U.S. government's ability to understand, forecast, and prepare for space weather events. Through this work, the U.S. government will further safeguard national security assets, critical infrastructure, and space operations, while fostering growth in U.S. commercial space and ground-based activities.

[1] See SWORM White Paper on the Implementation Status of the National Space Weather Strategy and Action Plan (January 2023). https://www.sworm.gov/publications/2023/2019_nswsap_ip_summary.pdf

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

Space weather poses a risk to civilian critical infrastructure, defense and intelligence systems, and military operations. Strengthening critical infrastructure security and resilience to space weather events requires an understanding of and a reduction in critical infrastructure vulnerabilities to the effects of space weather. Space weather can damage or disrupt space-based assets, jeopardize or impair crewed and uncrewed space activities, and adversely affect the ability to track objects in space. Protecting against the effects of space weather should inform satellite and spacecraft owners' and operators' design and engineering plans, mitigation strategies, and operational decision-making in the space environment. Space weather effects on ground systems, such as radars, or space-, air-, and ground-based communication links, pose a risk to national and homeland security. Developing and refining strategies to protect against and mitigate the potential disruptive effects of space weather, by hardening critical assets, for example, can minimize space weather risks and enhance resilience.

1.1 Refine space weather benchmarks that provide quantitative baselines to assess the intensity of space weather events.

1.1.1 Review the Next Step Space Weather Benchmarks report to determine if an update to the published Phase 1 Space Weather Benchmarks is warranted for any of the five benchmarked space weather phenomena. [DHS, DOC, DOD, DOE, DOI, NASA, NSF]

1.1.2 Develop a plan to address the existing gaps for the priority space weather benchmarks. This can be accomplished through a variety of mechanisms, including a series of technical conferences. [DHS, DOC, DOD, DOE, DOI, NASA, NSF]

1.1.3 Develop and publish additional rigorous space weather benchmarks. [DHS, DOC, DOE]

1.2 Assess the vulnerability of priority critical infrastructure systems and national security assets to the effects of space weather and use the results to inform risk management.

1.2.1 Once new benchmarks are developed, assess the need for further vulnerability analysis of priority critical infrastructure systems and national security assets. [DHS, DOD]

1.2.2 Determine the current maturity of existing terrestrial and in-space hazard maps, identify gaps, and create a plan for the development or improvement of the prioritized hazard maps. [DHS, DOC, DOI]

1.2.3 Develop and execute a plan that will use magnetotelluric (MT) survey data collection, geoelectric hazard maps, and location of critical electric substations to inform risk mitigation decisions. [DHS, DOC, DOE, DOI, FERC]

1.2.4 Identify a prioritized list of frequencies, which cause space weather sensors to be at risk from spectrum interference from electromagnetic emissions. [DOC, DOS, FCC]

1.2.5 Implement appropriate domestic and international protections to frequencies used by space weather sensors parallel to the protections given to terrestrial weather sensors. [DOC, DOS, FCC]

1.3 Model the effects of space weather on space-, air-, and ground-based national critical functions and associated priority critical infrastructure and national security systems, assets, and networks.

1.3.1 Review sector risk assessments to identify risk that would require the development of new or updated models to help facilitate risk mitigation. [All][2]

1.3.2 Department and agencies consider inclusion of identified space weather forecasting products and impact modeling capabilities during the normal budgeting process. [All]

1.3.3 Include space weather forecasting and impact modeling in operational planning and procedures, as appropriate. [All]

1.3.4 Examine mission performance targets to determine requirements for operational models to predict the effects of space weather on national security assets. [DOD]

1.3.5 Identify current impact models used for national security missions based on requirements and work with the research community to develop new and improved impact models and decision support tools. [DOD]

1.3.6 In collaboration with the research community, identify gaps in meeting the technical requirements for modeling the effects of space weather on national security assets using the survey of current impact models and develop a plan to address the identified gaps. The plan may include updates to existing models or the development of new models. [DNI, DOC, DOD]

1.3.7 Assess space weather impact models for national security assets to determine if the models adequately account for the effects of space weather events, assess the validation status of these models, identify the need for additional validations, and identify the resulting gaps in current modeling capabilities. [DNI, DOD]

1.3.8 Complete the MT survey of the United States. [DOI]

1.3.9 In recognition of the geographic variability and complexity of magnetic-storm-induced geoelectric hazards, and hazards related to nuclear electromagnetic pulses, identify locations with high hazard, large hazard uncertainty, or of strategic importance that could benefit from additional, higher-density MT surveys. [DOI]

1.4 Identify and assess the effects of frequent and extreme space weather events on operations and missions.

1.4.1 Estimate direct and indirect mission performance effects, in collaboration with departments and agencies and in consultation, as appropriate, with the relevant regulatory agencies. The estimates should be informed by the sector risk assessments requirement found in 6 U.S. Code § 655d. [DHS]

1.5 Assess the cost of space weather effects on the operations and implementation of critical missions.

[2] All SWORM subcommittee departments and agencies have a role in implementing the action.

1.5.1 Develop an initial analysis plan to estimate the cost to implementation of critical missions from extreme and low-intensity space weather events that are associated with operational delays, reduced capacity, component and system hardening costs, component or system damage, etc. For the purposes of this action, critical missions are defined as the sum of primary mission essential functions by federal department and agency. [All]

1.6 Identify and prioritize the research and development (R&D) necessary to enhance the security and resilience of critical functions and national security assets to the effects of space weather.

1.6.1 Assess the current portfolio of research relevant to the effects of space weather on priority infrastructure at risk identified in action 1.2. [DHS, DOC, DOD, DOI, NASA, NSF]

1.6.2 Conduct, as appropriate, an assessment with appropriate Federal and National Laboratories, private sector, and academia, to identify and recommend priority R&D gaps and needs to improve the security and resilience of infrastructure systems, assets, and networks that provide critical national functions and support the national security mission. [DHS, DOC, DOD, DOE, NASA, NSF]

1.6.3 Identify new system designs, technologies, and devices that enable systems to withstand the effects of space weather. Develop a plan to foster the R&D to achieve prototypes of the best systems, designs, technologies, and devices. [DOD, DOE]

1.7 Test, evaluate, and deploy technologies and devices to mitigate the effects of space weather on critical functions and assets.

1.7.1 Identify regulatory and non-regulatory mechanisms to address potentially catastrophic risk, in coordination with the heads of relevant departments and agencies, and in consultation with appropriate regulatory and utility commissions and other stakeholders. [DHS]

1.7.2 Conduct a pilot test to evaluate engineering approaches used to harden a strategic military installation, including infrastructure that is critical to supporting that installation, against the effects of geomagnetic disturbances and other space weather phenomena, in consultation as appropriate with the relevant regulatory agencies. [DHS, DOD, DOE]

1.7.3 Following completion of the pilot test directed in Action 1.7.2, report the cost and effectiveness of the evaluated approaches to OSTP and the NSC. [DHS, DOD, DOE]

1.8 Support the development and use of standards for improved resilience of equipment to space weather events.

1.8.1 Biennially convene an interagency working group to summarize the outputs of actions 1.2-1.7 and develop a list of systems, devices, and components for potential development of new standards for hardness or resilience to space weather. [DHS]

1.8.2 Consistent with OMB Circular A-119, Departments and Agencies will participate, as appropriate and relevant, in the development and use of voluntary, consensus standards for improved resilience of equipment to extreme space weather events. [All]

Objective II: Develop and Disseminate Accurate and Timely Space Weather Characterization and Forecasts

Timely and accurate space weather characterization and forecasts are critical to inform the planning, execution, and decision-making of operations for a diverse set of stakeholders including critical infrastructure owners and operators, the Department of Defense, and private sector satellite owners and operators. Improved understanding, observations, forecasts, and models for space weather events can lead to better quality and more timely space weather products and services, and contribute to supporting safe, stable, and sustainable space activities.

2.1 Identify baseline ground-based, sea-based, air-based, and space-based operational observation capabilities.

2.1.1 Update the baseline for space- and ground-based observations necessary to satisfy space weather forecasting requirements. Include the associated data reception, relay, processing, assimilation, and archiving infrastructure required to utilize space-weather observations in the baseline. [DOC, DOD, NASA, NSF]

2.1.2 Produce a plan for deployment of new operational space-weather-observing assets to provide the required observational capabilities specified in the baseline. [DOC, DOD, NASA, NSF]

2.1.3 Maintain U.S. input to the World Meteorological Organization Observing System Capability Analysis and Review database and encourage contributions of international partners to ensure comprehensive knowledge of international space-weather observational systems and their data products currently in use and planned for operational forecasting. This action will include information on ground- and space-based systems. [DOC, DOD, DOI, NASA]

2.2 Ensure baseline operational space weather observation platforms, capabilities, and networks.

2.2.1 Sustain or enhance an operational satellite mission to a position at least one million miles upstream of the sun-Earth line (e.g., the L1 Lagrange point). This mission will provide coronagraph, solar wind, energetic particle, and other measurements essential to space-weather forecasting. [DOC, NASA]

2.2.2 Sustain or enhance solar imaging and measurements of solar X-ray irradiance, energetic particles, and in situ magnetic field vectors from geostationary orbit. [DOC]

2.2.3 Develop a plan for obtaining future operational space-based auroral imaging and thermospheric neutral density data. [DOC]

2.2.4 Report on the progress on collaborations to provide operational capabilities off of the sun-Earth line (e.g., the L5 and/or L4 Lagrange points). These efforts could provide coronagraph, solar wind, energetic particle, and other measurements that would enhance forecasting capabilities. [DOC, NASA]

2.2.5 Sustain or enhance ground-based solar imaging, including solar magnetic field and H-alpha data for scientific purposes and operational forecasting. [DOC, DOD, NSF]

2.2.6 Collect design requirements for a potential future global ground-based solar observing network that incorporates NSF research as well as DOC and DOD operational needs. These may inform the design of a next generation solar observing network that includes solar magnetic field, white light, and H-alpha data. Formulate an interagency plan for coordination during the design and development process. [DOC, DOD, NSF]

2.2.7 Sustain or enhance ground-based solar radio capabilities that provide continuous observations of solar radio emission to operational forecasting centers. [DOC, DOD]

2.2.8 Sustain the existing ground-based geomagnetic monitoring network and enhance the network through the installation of new observatories that will deliver data to operational centers in real time. [DOC, DOI]

2.2.9 Enable and sustain the acquisition and delivery of satellite-based Global Navigation Satellite System radio occultation data with sufficient geographical coverage, data-rate, and latency to satisfy operational ionospheric-forecasting requirements. Ensure such data are assimilated into operational models of Earth's ionosphere. Integrate and assimilate commercial pilot Radio Occultation data into models. [DOC, DOD]

2.2.10 Update a collaborative Research-to Operations plan for the implementation of a global network of ground-based neutron monitors meeting scientific and operational forecast needs that includes delivery of real-time data to operational space weather forecast centers. [DOC, DOD, NSF]

2.2.11 Continue engagement with the relevant international bodies, such as the World Meteorological Organization, on issues relevant to operational space weather observations and report on priorities for coordinated actions. [DOC, DOI, DOS, NASA, NSF]

2.2.12 Explore additional opportunities to obtain space weather data from the commercial space weather sector. Assess the viability of assimilating the new commercially provided data into research and forecasting models and whether, and by how much, the data add value to space weather forecasts. [DOC, DOD, NASA]

2.2.13 Assess the value of space-based and ground-based observations in space weather specification and forecasting models and products. Identify ground-based and space-based observations necessary for operational services and ensure research-to-operations (R2O) continuity. [DOC, DOD, NASA]

2.3 Support and coordinate opportunities for fundamental research in heliophysics and geospace sciences.

2.3.1 Lead a biennial effort to prioritize and identify opportunities for R&D to enhance the understanding of space weather and its sources. These activities will be coordinated with existing national-level and scientific studies. This effort will include opportunities for the development and testing of models of the coupled sun-Earth system, the development of new observational space-based and ground-based techniques, and for the quantification of the long- and short-term variability of space weather. As part of the collaboration, regular exchanges will be conducted between agencies on research programs supporting space weather and their alignment with R&D priorities. [DOC, DOD, DOI, NASA, NSF]

2.4 Identify, develop, and test innovative approaches to enable enhanced, more informative, robust, and cost-effective measurements.

2.4.1 Lead an assessment with commercial and academic sector input, of what ground-based and space-based observation techniques can be improved or developed to advance space weather measurements. Use input from community efforts, such as the National Academies of Sciences, Engineering, and Medicine report on Space Weather Operations and Research Infrastructure Workshop. [DOC, DOD, DOI, NASA, NSF]

2.5 Enhance current space weather models and develop improved modeling techniques for space weather.

2.5.1 Establish model performance benchmarks and formalize the process to measure the performance and capabilities of operational and relevant scientific research models. This will assist with prioritization of new models for transition to operations and improvements of existing operational models. [DOC, DOD, NASA]

2.5.2 Define computational resource requirements for running and testing operational models. Explore existing computing resources with capabilities that meet the requirements. Identify possible augmentations or improvements to existing centers to meet the needs of the Space Weather Research-to-Operations functions. [DOC, DOD, NASA]

2.5.3 Identify, prepare, maintain and augment high quality datasets for assimilation, model validation, and to optimize utilization. Support development of forecasting capabilities based on statistical analysis, machine learning, and other innovative data science techniques. [DOC, DOD, DOI, NASA, NSF]

2.5.4 Enable, as appropriate, free, open, access to operational data streams and simulation outputs. [DOC, DOD, NASA, NSF]

2.5.5 Identify and support targeted basic and applied research opportunities that seek to advance solar and geospace models with the goal of improving space weather predictions. [DOC, DOD, DOI, NASA, NSF]

2.5.6 Coordinate development of assimilative modeling (in-situ observations and orbit information) for satellite drag and navigation/communication. [DOC, NASA]

2.5.7 Facilitate community-wide pre-event ensemble predictions. [NASA]

2.6 Identify and release, as appropriate, new or previously underutilized data sets.

2.6.1 Identify and release, as appropriate, historical data from U.S. government satellites, U.S. government-funded ground-based observatories and networks, in situ measurements throughout the electric power grid, and magnetometer data streams that would be beneficial for improving the development, validation, and testing of models used for characterizing and forecasting space weather events in consultation as appropriate with the relevant regulatory agencies. [DOC, DOD, DOE, DOI, NASA]

2.6.2 Release, as appropriate, historical data from the Los Alamos National Laboratory geostationary satellites. [DOC, DOD, DOE]

2.6.3 Release, as appropriate, historical data from the Defense Meteorological Satellite Program satellites. [DOC, DOD]

2.6.4 Release, as appropriate, data from hosted payloads aboard commercial satellites such as the radiation data from the Responsive Environmental Assessment Commercially Hosted (REACH) system on the Iridium-NEXT satellites. [DOC, DOD]

2.7 Identify mechanisms for sustaining and transitioning models and observational capabilities from research to operations.

2.7.1 Develop a baseline assessment of the current state of the space weather Research-to-Operations and Operations-to-Research (R2O2R) process. The assessment should identify the processes, characteristics, and limitations of the existing R2O2R structure. The assessment should also include a desired final state, which outlines the R2O2R target condition that departments and agencies want to achieve. [DOC, DOD, NASA]

2.7.2 Deploy the Space Weather R2O2R Framework and validate it with a demonstration, and where useful and ready, transition the results of one or more applied research capabilities into operations. The demonstration should validate key elements of the Framework and identify opportunities to improve the transition of space weather capabilities from Research-to-Operations and enhance Operations-to-Research. [DOC, DOD, NASA, NSF]

2.7.3 Develop the Space Weather Prediction Testbed (SWPT) as a key component of the formal R2O2R Framework. The SWPT will expand collaboration between researchers, developers, forecasters, and customers to validate, demonstrate, and accelerate the transition of advanced cutting-edge innovations and technology into operations. [DOC]

2.7.4 Develop the capability to provide research that supports operational responsibilities. This supporting research will result in effective transition and ingestion of relevant basic research and technologies to sustain an evolving and advanced operational capability for space weather monitoring, forecasting, and data archiving and dissemination. [DOC, DOD, NASA, NSF]

2.8 Enhance accessibility and sharing of observational data across the stakeholder Community.

2.8.1 Ensure availability and access to data identified in Actions 2.1 and 2.2. This action will include data from space-based and ground assets from both U.S. and international sources. [DOC, DOI, DOS]

2.8.2 Advocate, as appropriate, for open data access for space weather data in international fora and consider the development of standards for exchanging space weather data. [DOC, DOS]

2.8.3 Explore opportunities to leverage international partnerships to sustain baseline operational space-weather-observing capabilities. [DOC, DOI, DOS, NASA, NSF]

2.8.4 Lead the development of an International Space Weather Coordination Group that provides a forum where the federal departments and agencies that fund space weather missions and research meet to share their plans, as well as coordinate missions and research funding relevant to space weather. [DOC, DOD, DOS, NASA, NSF]

2.9 Improve the effectiveness of space weather event notifications.

2.9.1 Using results from the Space Weather Advisory Group User Needs Survey, refine the lead time, accuracy, and uncertainty requirements for routine forecasts and event-driven hazard products given the current and near-term state-of-the-art in space weather forecasting. [DHS, DOC, NASA]

2.9.2 Develop actionable, impact-based prototype products to ensure appropriate responses from end-users of space weather information. [DHS, DOC]

2.9.3 Update and expand, as appropriate, the NOAA space weather scales. NOAA scales should be updated and expanded with a focus on forecasting impacts and specifying how space weather will differentially affect systems, industries, sectors, or regions. [DHS, DOC]

2.9.4 Identify and implement improvements to space weather products in support of aviation. This should include improvements, as appropriate, to International Civil Aviation Organization space weather products and services. [DOC, DOT]

2.10 Engage international partners to ensure space weather products and services are globally coordinated and consistent, as appropriate, during extreme events.

2.10.1 Use technical bilateral and multi-country relationships with partners to coordinate products, services, and messaging for extreme events. [DOC, DOD, DOS, NASA]

2.10.2 Engage in multilateral fora to promote the adoption of U.S. products, services, and messaging. [DOC, DOD, DOS, NASA]

2.10.3 Use relationships and diplomatic infrastructure to engage international partners for collaboration and broad buy-in on supporting dedicated observation systems. [DOC, DOS, NASA, DOD]

2.11 Develop and refine situational awareness capabilities.

2.11.1 In coordination with academia, the private sector, and international partners, develop and/or improve models for the real-time assessment of radiation levels at and above commercial flight altitudes to support the aviation and space exploration industries. [DOC, DOT, NASA]

2.11.2 Survey existing resources to provide real-time monitoring of ionospheric conditions across the radio spectrum, and develop a plan for a robust real-time assimilative environmental specification model such that it supports nowcasting of ionospheric variability. [DHS, DOC, DOD, FCC, NASA, NSF]

2.11.3 Define the requirements for measurements, reporting, and data storage of grid conditions such that DOE has an appropriate level of insight into grid operations during the event of an impending or existing extreme space weather event, and anomalies due to routine and extreme space weather can be analyzed. [DOC, DOE, DOI]

2.11.4 Review options for automated satellite telemetry scanning systems, which have correlative value in attributing on-orbit anomalies to space weather. [DOC, DOD, NASA]

2.11.5 Develop a plan for a robust real-time assimilative environmental specification model such that it supports nowcasting of the space environment, and analysis and attribution of spacecraft anomalies due to routine and extreme space weather. [DOC, DOD, NASA]

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

The ability to rapidly respond to and recover from extreme space weather events requires coordinated efforts and established plans and procedures. Conducting exercises to test and validate these plans and strategies can allow relevant stakeholders to practice and refine them. An improved understanding of critical system and asset vulnerabilities to the effects of space weather (Objective I), and a robust forecasting capability that can enable more timely and accurate services and products (Objective II) are important to inform the efforts of federal, state, and local governments, as well as private sector and others' efforts, capabilities, and investments in managing space weather events.

3.1 Develop, review, and update Federal response plans, programs, and procedures to address the effects of space weather.

3.1.1 Incorporate the latest data on the threats and vulnerabilities from extreme space weather into national risk assessment documents. [DHS, DOC]

3.1.2 Review and update the Federal Operating Concept for Impending Space Weather Events. [DHS]

3.1.3 Informed by intelligence-based threat assessments, develop quadrennial risk assessments on electromagnetic pulses (EMPs) as directed by Executive Order 13865 and 6 U.S. Code §195f. [DHS, DOD, DOE]

3.1.4 Develop and update operational plans documenting procedures and responsibilities of Federal Departments and Agencies to prepare for, protect against, and mitigate the effects of impending space weather events, informed by the Federal Operating Concept and compatible with the National Preparedness System described in Presidential Policy Directive-8. [All]

3.1.5 Refine strategic messaging and communications for an impending extreme space weather event to ensure the U.S. government is prepared and collaborates to communicate effectively to minimize incorrect information. [DHS, DOC, NSC]

3.1.6 Develop a National Security Annex to the National Space Weather Strategy and Action Plan. [All]

3.1.7 Develop an agency-wide strategy to ensure effective coordination and implementation of NOAA's PROSWIFT authorities and national space weather policy responsibilities and activities. [DOC]

3.1.8 Assess and establish standing Memorandum of Understanding or Memorandum of Agreements between SWORM departments and agencies to enable efficient coordination and collaboration. [All]

3.1.9 Develop a visual aid to brief senior government leadership on an impending extreme space weather event. [DHS, DOC, DOE, WHMO]

3.2 Develop and disseminate products and information on the effects of space weather that support coordinated response and recovery efforts.

3.2.1 Coordinate sustained U.S. participation in relevant international space-weather initiatives, and include emergency management protocols that support coordinated response and recovery efforts. This action will include participation in United Nations activities and incorporation of space-weather-related elements into work plans, programs, and projects. [DOC, DOS]

3.2.2 Improve public awareness, education, and engagement regarding space weather and its effects. Develop a strategy to promote societal awareness of space weather. [DHS, DOC, NASA, NSF]

3.3 Facilitate information sharing to inform and enhance the operation and restoration of critical infrastructure at greatest risk to the effects of space weather.

3.3.1 Implement and sustain a satellite-anomaly attribution information system including temporary upsets in function, loss of communications, or failure of the satellite, which can be used to better understand and model the effects of space weather on satellite operations. The output of this system will be available to appropriate satellite operators and space weather experts. [DOC, DOD, NASA]

3.3.2 Improve utility and inoperability of transmission grid and Ground-Based Midcourse Defense-related data collected during geomagnetic storms as specified in the Federal Energy Regulatory Commission Order No. 830. [DOC, DOE, DOI, FERC]

3.3.3 Coordinate with aviation stakeholders to collect and archive space weather effects on aviation operations during space weather storms to develop, validate, and improve space weather models and services. [DOC, DOT]

3.4 Assess executive and statutory authority regarding the ability to direct, suspend, or control critical infrastructure operations, functions, and services before, during, and after space weather events.

3.4.1 Review, analyze, and update executive and statutory authority regarding the ability to direct, suspend, or control critical infrastructure operations, functions, and services before, during, and after space weather events, to incorporate recent statutory, policy and regulation activities. [All]

3.5 Exercise federal response, recovery, and operations plans and procedures for space weather events.

3.5.1 Incorporate exercise objectives tailored to testing and evaluating the nation's capabilities to respond to and recover from the potential impacts of benchmarked space weather events within relevant exercises. [DHS]

3.5.2 Incorporate infrastructure impact models that generate data and help determine decisions or make predictions about a system (e.g., grid transmission system or satellite systems such as Global Navigation Satellite System and Low Earth Orbit constellations) into existing and future exercises to develop realistic space weather scenarios for response and recovery, including societal impacts. [DHS, DOC]

Conclusion

Space weather encompasses a wide array of phenomena which have the potential to negatively affect technology and infrastructure critical to our nation's security and economy. When implemented, the actions outlined in this 2023 Implementation Plan will enhance national preparedness for and resilience to the effects of space weather. With coordination across the federal government, the Space Weather Advisory Group, academia, the private sector, and international partners these high-level actions will help to achieve a space-weather-ready nation.

Abbreviations and Acronyms

DHS	Department of Homeland Security
DOC	Department of Commerce
DOD	Department of Defense
DOE	Department of Energy
DOI	Department of the Interior
DOS	Department of State
DOT	Department of Transportation
EPA	Environmental Protection Agency
FCC	Federal Communications Commission
NASA	National Aeronautics and Space Administration
NRC	Nuclear Regulatory Commission
NSC	National Security Council
NSF	National Science Foundation
WHMO	White House Military Office