

# Space Weather Strategy

NASA is establishing a NASA Space Weather (NSWx) Program as a distinct program within the Heliophysics Division (i.e., separate from the Living With a Star Program). Its space weather strategic goals and objectives are based on the recognition that space weather is an applied expression of heliophysics. It is consistent with the goals of and the Agency responsibilities identified in the 2019 Promoting Research and Observations of Space Weather to Improve the Forecasting of Tomorrow (PROSWIFT) Act and is codified in the 2020 NASA Science Plan with the Agency's first Priority, "Exploration and Scientific Discovery":

- *Strategy 1.4.* Develop a Directorate-wide, target-user focused approach to applied programs, including Earth Science Applications, Space Weather, Planetary Defense, and Space Situational Awareness.

## Vision

Advance the science of space weather to empower a technological society safely thriving on Earth and expanding into space.

## Mission

Establish a preeminent space weather capability that supports robotic and human space exploration and meets national, international, and societal needs by advancing measurement and analysis techniques, and by expanding knowledge and understanding for transitioning into improved operational space weather forecasts and nowcasts.

## Goals

NASA plays a vital role in space weather research by providing unique, significant, and exploratory observations and data streams for theory, modeling, and data analysis research, and for operations. NASA's contributions to observing and understanding space weather are critical for the success of the National and International space weather enterprise. NASA has a preeminent space weather capability through the pursuit of the following goals and objectives:

1. **Observe:** Advance observation techniques, technology, and capability
  - 1.1 Identify technologies and techniques for which enhanced or future investments would produce results that significantly and positively impact space weather understanding and prediction
  - 1.2 Create opportunities to develop observation techniques and instrumentation
  - 1.3 Establish and sustain recurrent flight cadence and supporting infrastructure opportunities for space weather instrumentation and missions
  - 1.4 Identify and implement the capability to ensure that real-time and latent data streams for space weather-relevant space observations are available
2. **Analyze:** Advance research, analysis, and modeling capability
  - 2.1 Identify analysis capabilities that would advance space weather understanding and prediction

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- 2.2 Establish opportunities to support the development of improved data analysis and modeling capabilities
  - 2.3 Work with NSF and other federal agencies to advance research and analysis capabilities relevant to space weather
3. **Predict:** Improve space weather forecast and nowcast capabilities
    - 3.1 Develop a structure and process that funnels basic research information to an applied focus
4. **Transition:** Transition capabilities to operational environments
    - 4.1 Create a pipeline that conveys the results and outputs of the NASA Heliophysics research and technology programs to a space weather proving ground environment where models and techniques are assessed
    - 4.2 In coordination with NOAA, establish a testbed capability to transition forecasting and nowcasting models (Space Weather Prediction Center) and transition observations and data streams (National Environmental Satellite Data and Information Service)
    - 4.3 Establish formal relationships between NASA and DoD to exchange data and observation capabilities, and effectively transition data, improved forecasting and nowcasting capabilities, and improved observation techniques
5. **Support:** Support Robotic and Human Exploration
    - 5.1 Advance the partnership between the Heliophysics Division and the Human Exploration and Operations Mission Directorate (HEOMD) to provide expertise on space environment conditions that enable the health and safety of astronauts beyond low-earth orbit
    - 5.2 Provide key real-time data streams to the Agency for forecasting, nowcasting, and anomaly resolution for robotic and crewed missions
6. **Partner:** Meet national and international needs consistent with U.S. government directives
    - 6.1 Secure the counsel of space weather experts within the government, academia, commercial, and private sector
    - 6.2 Provide key real-time data streams to sister agencies for forecasting, nowcasting, and anomaly resolution
    - 6.3 Continue active participation at the Executive level with Office of Science Technology and Policy (OSTP)
    - 6.4 Represent the U.S. in international space weather research fora to advance the global capability and enhance U.S. ability to meet its space weather needs

## Appendix A

### NSWx Planning Information

*Below is strategic implementation planning information, which describes the expected activities that will have been completed or will be underway by CY2024. This information will not address collaborative or advisory interactions (e.g. inter-agency coordination, National Academies reports) unless those could potentially result in the initiation of new projects.*

*All information is notional and does not reflect any project (including procurement) commitments unless otherwise stated.*

**Objective 1.3:** Establish and sustain recurrent flight cadence and supporting infrastructure opportunities for space weather instrumentation and missions

- Action: Develop and launch a NASA-led pathfinder mission that contributes significantly to the National space weather enterprise
  - Activity: Stand-alone mission, focused scope. Restricted to high-need technological and/or scientific topics identified by NASA.

**Objective 3.1:** Develop a structure and process that funnels basic research information to an applied focus

- Action: Create opportunities to use existing and past observations to develop improved forecast and nowcast capability
  - Activity: Research solicitation in coordination with space weather partner Agencies. Short-duration awards focused on discrete, measurable closure of forecast and nowcast capability gaps.

**Objective 4.2:** In coordination with NOAA, establish a testbed capability to transition forecasting and nowcasting models (SWPC) and transition observations and data streams (NESDIS).

- Action: Create opportunities for the scientific community and the Goddard Space Flight Center (GSFC) Community Coordinated Modeling Center to test and validate forecast and nowcast models that show promise for operational environments
  - Activity: Identify mechanisms for sustaining and transitioning models and observational capabilities from research to operations in collaboration with NOAA, NSF, DoD.
    - Milestone(s): Research-to-operations-to-research (R2O2R) Framework Document to enhance and accelerate the transition from research to operations, including academic, private sector, and international partnerships, where appropriate (initially with NOAA, then later NSF, DoD).

**Objective 5.3:** Advance the partnership between the Heliophysics Division and HEOMD to provide expertise on space environment conditions that enable the health and safety of astronauts beyond low Earth orbit

- Action: Identify opportunities to manifest space observation capabilities to improve forecasting of space environment in support of space exploration
  - Activity: Deliver HERMES payload for integration onto Gateway module.
    - Milestone(s): HERMES payload selections [March 2020]. HERMES KDP-C [January 2022].

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- Activity: Compete HERMES science team for focused science investigations.
  - Milestone(s): First HERMES Interdisciplinary Scientist selections [June 2021].
- Action: Provide key real-time data streams to the Agency for forecasting, nowcasting, and anomaly resolution for robotic and crewed missions
  - Activity: Establish agreements with NOAA on delivery of NASA science mission data for space weather operational uses

**Objective 6.1:** Secure the counsel of space weather experts within the government, academia, commercial and private sector

- Action: Sponsor committees and other groups as community-based, interdisciplinary forums for NASA to solicit and coordinate community analysis and input.
  - Activity: Establish Space Weather Council as subcommittee to the NASA Heliophysics Advisory Committee (HPAC)
    - Milestone(s): Council chartered [April 2021]. Council populated [June 2021].
  - Activity: Establish an Academic-Commercial Roundtable, under the auspices of the National Academies of Science, Engineering, and Medicine and in collaboration with NOAA and NSF, to facilitate communication and knowledge transfer among Government participants in the space weather interagency working group to:
    - Facilitate advances in space weather prediction and forecasting;
    - Increase coordination of space weather research to operations and operations to research; and
    - Improve preparedness for potential space weather phenomena

**Objective 6.4:** Represent the U.S. in international space weather research fora to advance the global capability and enhance U.S. ability to meet its space weather needs

- Action: Partner with international agencies to further the capability of space weather forecasting/nowcasting
  - Activity: Discuss with ESA about potential NASA participation in the Vigil mission
  - Activity: Discuss with CSA about potential NASA participation in the Arctic Observation Mission

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**Appendix B**  
**NSWx Strategy Table**

For communication purposes, this Appendix includes the strategy table used in internal NSWx documents. This table may be used in external documents provided proper attribution is made.

NSWx Strategy by Goal			
Theme	Goal	Objective	
<b>1. Observe</b>	Advance observation techniques, technology, and capability	1.1	Identify technologies and techniques for which enhanced or future investments would produce results that significantly and positively impact space weather understanding and prediction
		1.2	Create opportunities to develop observation techniques and instrumentation
		1.3	Establish and sustain recurrent flight cadence and supporting infrastructure opportunities for space weather instrumentation and missions
		1.4	Identify and implement the capability to ensure that real-time and latent data streams for space weather-relevant space observations are available
<b>2. Analyze</b>	Advance research, analysis and modeling capability	2.1	Identify analysis capabilities that advance space weather understanding and prediction
		2.2	Establish opportunities to support the development of improved data analysis and modeling capabilities
		2.3	Work with NSF and other federal agencies to advance research and analysis capabilities relevant to space weather
<b>3. Predict</b>	Improve space weather forecast and nowcast capabilities	3.1	Develop a structure and process that funnels basic research information to an applied focus
<b>4. Transition</b>	Transition capabilities to operational environments	4.1	Create a pipeline that conveys the results and outputs of the NASA Heliophysics research and technology programs to a space weather proving ground environment where models and techniques are assessed
		4.2	In coordination with NOAA, establish a testbed capability to transition forecasting and nowcasting models (SWPC) and transition observations and data streams (NESDIS).
		4.3	Establish formal relationships between NASA and DoD to exchange data and observation capabilities, and effectively transition data, improved forecasting and nowcasting capabilities, and improved observation techniques.
<b>5. Support</b>	Support Robotic and Human Exploration	5.1	Advance the partnership between the Heliophysics Division and HEOMD to provide expertise on space environment conditions that enable the health and safety of astronauts beyond low-earth orbit
		5.2	Provide key real-time data streams to the Agency for forecasting, nowcasting, and anomaly resolution for robotic and crewed missions
<b>6. Partner</b>	Meet national, international, and societal needs consistent with government directives	6.1	Secure the counsel of space weather expertise within the government, academia, commercial and private sector
		6.2	Provide key real-time data streams to sister agencies for forecasting, nowcasting, and anomaly resolution
		6.3	Continue active participation at the Executive level with OSTP
		6.4	Represent the U.S. in international space weather research fora to advance the global capability and enhance U.S. ability to meet its space weather needs