National Aeronautics and
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**Committee on Science, Space,
and Technology**

United States House of Representatives

Statement by:

Dr. Joseph Westlake, Division Director for Heliophysics, Science Mission Directorate
National Aeronautics and Space Administration

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Statement of
Dr. Joseph Westlake, Division Director, for Heliophysics, Science Mission Directorate
National Aeronautics and Space Administration
before the
Committee on Science, Space, and Technology
United States House of Representatives
Regarding
Weathering the Solar Storm: Advancing America's Space Weather Capabilities

Chairman Babin, Ranking Member Lofgren, and distinguished members of the Committee, I am Dr. Joseph Westlake, Director of NASA Science's Heliophysics Division. Thank you for the opportunity to appear before you today to discuss NASA's vital role in America's space weather enterprise.

American superiority in space requires space weather knowledge to safeguard our path across the solar system just a few years from now. Imagine American astronauts standing on a sunlit plain at the lunar south pole. Under the gleam of their visors, they receive a real-time notification from NASA, using data from missions such as NASA's IMAP, that a severe solar energetic particle event is underway. This automated alert provides them with the precise window of time they have to safely power down external systems, secure the newly activated lunar nuclear fission reactor, and retreat to the protective habitat of Moon Base.

Millions of miles further away, against the dusty red backdrop of the Martian horizon, a crew of American explorers is arriving. Their Earth-independent systems receive space weather data and a Sun-Mars Lagrange point (L1) spacecraft, built from the foundation provided by missions like NASA's ESCAPADE, watching for solar storms and radiation spikes, seeking updates about whether it is safe to step out of the protective haven of their ship to place the first human footprints on the surface of Mars.

Meanwhile at home on Earth, space weather, the dynamic interactions between the electromagnetic fields and particles emitted by our Sun and the rest of the solar system, touches the daily lives of every American in profound ways. We see it when airline pilots navigate high-altitude polar routes safely, when farmers in the Midwest rely on precision GPS signals to plant

and harvest their crops, and when thousands of families look up to the night sky, witnessing the breathtaking majesty of an auroral display for the very first time. Supporting all of this is a thriving space economy, where thousands of companies depend on accurate, real-time information about the space environment—not just to prepare for major solar storms, but to manage everyday space weather safely and without system, infrastructure, or mission disruption.

This is not a distant, abstract science fiction dream. The President's recent Executive Order on Ensuring American Space Superiority calls for returning Americans to the Moon by 2028, establishing permanent lunar outpost capabilities by 2030, and aggressively laying the groundwork for the human journey to Mars, all while growing a vibrant commercial space economy at home. Core to achieving these goals, and directed in the Executive Order and the 2026 National Resilience Strategy, is improving high-value space weather forecasting and operations to meet needs on Earth and beyond.

Enabling these advanced space weather capabilities requires an all-of-government, commercial-integrated approach, which is exactly what the PROSWIFT Act directed when President Trump signed it into law in 2020. NASA's role is to serve as the tip-of-the-spear research entity delivering advanced and novel capability to predict space weather, implement and manage a program to transition those advances into the hands of forecasters for civil and national defense applications, support NASA missions across the solar system with space weather information, and to operate spacecraft that collect vital data to enable all of the above. I will give updates on each one of these elements now.

Research Enabling Advanced Capabilities

Scientific research is the bedrock of our innovation, delivering the paradigm-shifting insights that only the American scientific community can produce. NASA's Heliophysics Research and Analysis (R&A) portfolio systematically studies the entire Sun-to-Earth system, empowering our academic communities, research laboratories, and commercial partners to transform raw curiosity into actionable national security and economic capabilities.

Crucially, NASA is pioneering the next frontier of space weather science through advanced computational modeling and artificial intelligence (AI). NASA's space-based observatories capture vast amounts of data, but raw observations alone cannot protect a power grid or an astronaut. Modeling and AI serve as the critical, indispensable link that converts American investments in hardware and observations into high-fidelity, predictive insights, and actionable information—projecting space weather affects with unprecedented skill, speed, and accuracy.

A cornerstone of this visionary approach is our strategic establishment of Space Weather Centers of Excellence. These multidisciplinary hubs serve as premier incubators for revolutionary science, uniting academic minds, commercial innovators, and operational end-users. By tackling

the complex physics of the heliosphere—such as predictive modeling of solar flares long before they erupt—these Centers accelerate the transition of basic research into operational readiness, providing the foundational breakthroughs that protect civilian and defense systems alike.

Applications for Operational Users

A core responsibility of NASA in PROSWIFT is the implementation of the Space Weather (SWx) Research-to-Operations-to-Research (R2O2R) program that harnesses the scientific might of the United States to create and transition cutting-edge space weather predictive capabilities to meet the needs of forecasters and society. At its heart, this program is driven by NASA's firm commitment to the American public: we do not measure our success only by the scientific insights we discover, but also by our ability to put those insights to work. We are dedicated to continue working with our partners at NOAA, NSF, and the Department of War to ensure that SWx R2O2R is enabling taxpayer-funded space weather observations and scientific breakthroughs are developed into tangible, real-world applications and transitioned to operational partners to empower services that add value through direct benefit to our citizens, our businesses, and our national security.

To enable success in this pipeline, NASA and NOAA introduced three pivotal management and infrastructure updates in 2025:

- The opening of the NASA Space Weather Program-Implementation Office at Langley Research Center in Virginia to provide support and management to these projects.
- NASA released a brand-new, user-centric solicitation designed to build direct, collaborative bridges between scientists, forecasters, and end-users from day one, ensuring our research is aimed at solving real-world challenges.
- Deepened collaboration with the NOAA Space Weather Prediction Testbed to support transition activities and create an environment where NASA's scientific models can be rigorously tested under true operational conditions.

The refined SWx R2O2R architecture is already yielding remarkable successes. We measure the maturity of these transition projects using Readiness Levels (RLs), tracking their progression from basic research (RL1) to fully integrated, 24/7 operational capabilities (RL9). Over the past 12 months, several key initiatives successfully advanced one or more RL:

  - **Commercial Aviation Safeguards:** NASA worked with commercial airline pilots to develop a new, tailored model output of radiation dosage to enable transatlantic commercial flights to change their route for safer conditions during solar storms
  - **Severe Storm Prediction:** Integration of new data sources in the Nation's operational model for predicting the arrival time and intensity of solar storms
  - **Deep Space Astronaut Protection:** A brand-new deep space radiation model tailored for astronaut crew safety was tested during the Artemis II mission

- **Emergency Communications Resilience:** Optimization and integration of new datasets to enable emergency managers to be aware of potential radio communication disruptions up to 10 to 30 minutes earlier than presently possible.
- **Defense Aviation Security:** Tailored radiation model output and graphics support national security activities specifically for high-altitude military aircraft crew safety during enhanced space weather activity.

This military aviation tool proved its worth immediately. During recent solar storms, the U.S. Air Force utilized these insights to inform decisions to ensure crew safety of high-altitude flights, directly protecting personnel.

As reflected in these examples, the tools coming out of the R2O2R program directly address real-world challenges, build new capabilities for operational space weather forecasters, and enable the development of new services to inform decision-making.

Supporting NASA Exploration

When it comes to deep-space exploration, both robotic and human spaceflight, the ultimate responsibility for NASA astronaut and mission safety and the execution of the President's vision rests with NASA. Protecting American crews and robotic explorers traveling millions of miles from Earth across the solar system on NASA missions is an operational mandate that cannot be outsourced or delegated. To meet NASA's unique mission needs as directed in PROSWIFT, NASA established the Moon to Mars Space Weather Analysis Office (M2M SWAO) to provide tailored space weather assessments and anomaly analysis for NASA robotic and human missions across the solar system.

M2M SWAO works lockstep with the Space Radiation Analysis Group (SRAG) at NASA Johnson – NASA's lead for ensuring astronaut safety with radiation exposure - and NOAA's Space Weather Prediction Center to keep NASA human exploration missions like Artemis safe. This collaborative framework was put to the test during the historic Artemis II mission, providing the constant, high-fidelity monitoring and immediate decision support required to protect our crew as they journeyed beyond the protective shield of Earth's magnetosphere for the first time in over fifty years.

Our capability to safeguard these explorers is continuously bolstered by the launch of cutting-edge missions. Over the past year, we have deployed key assets, including the Polarimeter to Unify the Corona and Heliosphere (PUNCH) mission, which provides three-dimensional tracking of solar eruptions across the solar system, and the Interstellar Mapping and Acceleration Probe (IMAP), which tracks the boundaries of our heliosphere and the solar wind flowing toward the Earth-Moon system. Looking toward future crewed infrastructure, our Heliophysics Environmental and Radiation Measurement Experiment Suite (HERMES) is fully built and ready to serve as an autonomous space weather station onboard future human spaceflight missions.

By pushing the boundaries of space weather prediction for our astronauts, we are simultaneously refining the predictive models that protect America. This taxpayer-funded science conducted throughout the solar system through the Heliophysics System Observatory translates directly into grid resilience, aviation safety, precision agriculture continuity, and greater economic security at home.

We are living in a historic moment, the dawn of a golden age of science and exploration. The strategic decisions we make today, the advanced architectures we fund, and the collective national resolve we demonstrate will set the trajectory of American leadership in space for generations to come. Supported by Congress and the all-of-government, commercially integrated direction of the PROSWIFT Act, and energized by the bold leadership of the President, we are preparing to go to the Moon and then onward to Mars, and we are bringing the benefits of that grand adventure home to every single American.

Thank you for this opportunity to testify, and I welcome your questions.