

National Aeronautics and
Space Administration



EXPLORESCIENCE

Heliophysics Space Weather

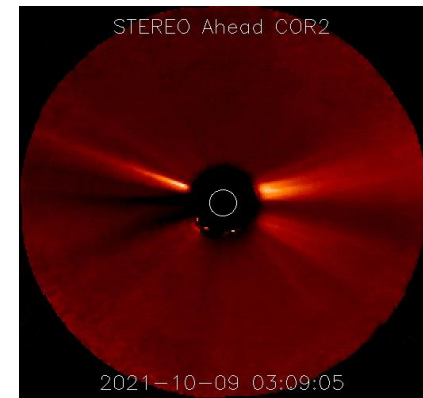
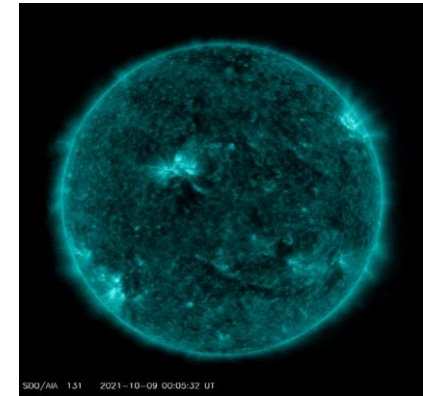
Decadal Survey Supplemental Presentation

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NASA & Space Weather

- 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 Heliophysics Division is uniquely poised to support needs of the National and International space weather enterprise and the Agency's Artemis.
- Various executive (NSW SAP) and legislative (PROSWIFT Act) mandates direct NASA to address research and application aspects of space weather which allows NASA to do what NASA does best – push the envelope by pursuing forward-leaning developmental activities.
- Making use of NASA's unique capabilities and directly addressing the legislative mandate, HPD has established the new NASA Space Weather Program, a national resource to unify space weather research and drive our understanding of its risks, impacts and mechanisms into new realms.



NASA Space Weather Program Strategy

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.

1. Observe

- Advance observation techniques, technology, and capability

2. Analyze

- Advance research, analysis and modeling capability

3. Predict

- Improve space weather forecast and nowcast capabilities

4. Transition

- Transition capabilities to operational environments

5. Support

- Support Robotic and Human Exploration

6. Partner

- Meet National, International, and societal needs consistent with Government directives



NASA's Space Weather Program

The NASA Space Weather Program (NSWx) focuses on research and investigations primarily motivated by its application to space weather.

The National and International necessity of operational space weather forecasting, requires the effective transition of space weather relevant scientific knowledge, capabilities and technology to operational and application environments.

The NSWx Program is the logical next step for NASA to enable the advancement of space weather scientific understanding that will be transitioned and applied to real-world needs. The improvement of existing operational capabilities and the development applications are used to support users throughout the R2O2R loop.



Current Space Weather Program Activities [1]

NASA's Space Weather Program comprises of space weather research development that leads from understanding to transition and application, in support of the space weather enterprise.

Space Weather Research to Operations / Operations to Research (R2O2R)

- Competed research program that supports the transition of scientific capabilities (e.g. models, techniques) to operational use
- A yearly element conducted on behalf of NASA, NOAA, and NSF under a tri-agency agreement.
- ROSES-22 focused topics:
 - High-Latitude Radiation Exposure
 - Downstream Updating of Solar Wind & CME Forecasts
- R2O2R Framework and Quad-Interagency Agreement

HERMES & Gateway

- NASA's space weather instrument suite, led by HPD, will observe solar particles and the solar wind.
 - NASA: HERMES (Heliophysics Environmental and Radiation Measurement Experiment Suite)
 - ESA: ERSA (ESA Radiation Sensors Array)
 - ESA/JAXA: IDA (Internal Dosimeter Array)
- Serves as a pathfinder mission for future missions to establish an earth-independent space weather capability for long duration missions beyond the earth-moon system.
- Six Competitively-Selected Interdisciplinary Science (IDS) Teams, including international partners, will work with the HERMES Instrument Teams



Current Space Weather Program Activities [2]

Space Weather Centers of Excellence

- Supports research and infrastructure development to make measured progress on major space weather challenges
 - Focus on integrated, multidisciplinary efforts
 - Explicitly and fundamentally incorporates R2O and O2R

Space Weather SBIR Subtopic

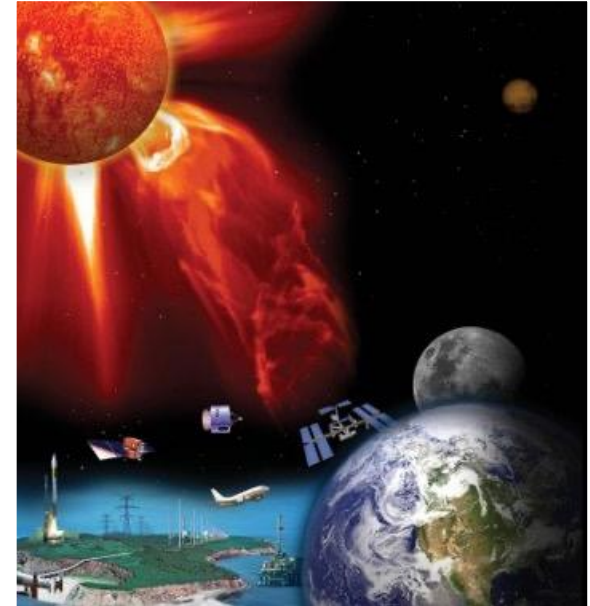
- Small Business Innovation Research (SBIR) program supports the transformation of scientific discovery into innovative products and services that could be commercialized and infused into NASA projects
- Space Weather Program supports SBIR projects that could enable or enhance space weather spaceflight and R2O2R activities
 - Phase II Selections: (1) Parallelization Toolkit for NASA CCMC (2325), (2) Advanced Climatology Innovations for Space Radiation Environments (3081).

Heliophysics System Observatory

- Effectively leverage current and forthcoming HPD assets to address Space Weather goals – e.g. HelioSwarm, PUNCH, and SunRISE, various CubeSats

Planned Near-Term Activities

- Develop space weather instrument pipeline for future opportunities
- Engage international partners on future collaborations (e.g. ESA Vigil, CSA AOM, ESA ITM mission, KASI SNIPE, ISRO Aditya)
- Continue transitioning Radiation Assessment Detector (RAD) instrument on Curiosity rover on Mars from Planetary Science Division to the Heliophysics Division to engage space weather community supporting forecasting research at Mars
- Continued funding R2O2R grants and SWx SBIR efforts - >70 funded efforts with multiagency input (DoD/NOAA/NSF/NASA)
- PROSWIFT: Actions responding to PROSWIFT Act are well underway
- Coordinate Orbital Debris/Space Situational Awareness efforts focusing on the impact of space weather on orbital dynamics and space traffic control





Future Space Weather Program Activities

It is anticipated that future activities will include:

- Investigations that address Space Weather Program scientific, pre-operational needs, including but not limited to
 - Pathfinder missions that lead to the establishment of Earth-independent space weather capabilities (i.e. not dependent on ground-based decision-making capabilities)
 - Loosely coupled programs that support and leverage elements of Heliophysics System Observatory missions
 - Investigations and program elements that support of NASA human exploration activities
 - Development and demonstration of innovative techniques and technologies that enable new or enhance existing capabilities, for the purpose of transition to operational partners



Request for the Decadal Survey [1]

Charge to the Decadal Survey Committee: *Provide an overview of the current state of solar and space physics science and applications, including: The space weather pipeline from basic research to applications to operations, including the research-to-operations-to-research loop that strengthens forecasting and other predictive capabilities.*

The survey should make recommendations for the healthy and sustainable implementation of the Heliophysics spaceflight mission programs. These include the ... [NASA Space Weather] program...

- Comment on the role and range of applicability of the NASA Space Weather Program within the Heliophysics Division and within the broader space weather enterprise
 - Identify potential improvements in NASA's Space Weather Strategy, including its interfaces to other NASA programs and other organizations (e.g. NASA human spaceflight, Government stakeholders, commercial stakeholders, academia, international partners)



Request for the Decadal Survey [2]

- Assess and comment on the appropriate balance of resources and emphasis within the NASA Space Weather Program for space weather including, but not limited to (1) research and application, (2) transition research to operations, and (3) missions
 - Recommend the optimal balance of activities within the Space Weather Program, including but not limited to
 - applied research investigations
 - research to operations transition activities
 - spaceflight investigations
- Assess and recommend improvements of the space weather research and applications including, but not limited to (1) annual R2O2R solicitation that NASA manages on behalf of NSF, NOAA, and DoD, (2) Space Weather Centers of Excellence, (3) Space Weather SBIR, and (4) pipeline instruments



Request for the Decadal Survey [3]

- Prioritize missions within the Heliophysics programs that are directly relevant to space weather operations at Earth and beyond, including both cis-lunar and cis-martian space
 - Prioritize research and spaceflight investigations for implementation within the Space Weather Program, including those that are directly applicable to space weather operational needs at Earth, within the cis-lunar and cis-martian space environments, and in interplanetary space
 - Identify and prioritize those missions that should be managed under the NASA Space Weather Program
- Clearly incorporate budget guidance for recommended activities

The background of the slide is a composite of two cosmic images. The top half features a dark space filled with numerous small, distant stars and a prominent, glowing blue nebula on the right side. The bottom half shows a similar starry field but with a more vibrant color palette, including bright yellow and orange stars on the left, transitioning to green and blue on the right, with a faint, wispy nebula in the center. A horizontal light blue band runs across the middle of the image, containing the text.

#HelioRocks