Space Weather Advisory Group (SWAG) Recommendations and Perspectives

NAS Space Weather Roundtable

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All opinions are my own and not those of SWAG or Lockheed Martin

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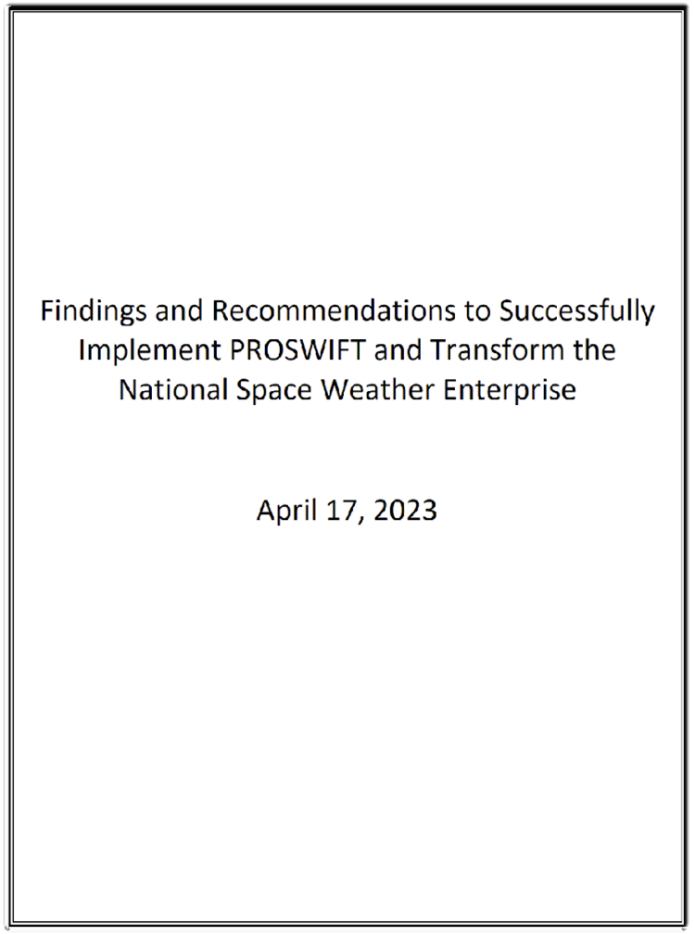
Developing Recommendations

- Asked by SWORM to provide input to inform updates to National Space Weather Strategy, Action Plan, or Implementation Plan
- Input for the report
  - 2015 and 2019 Strategies and Action Plans
  - White Paper on the Implementation Status of the National Space Weather Strategy and Action Plan
  - National space weather policies and statutes
  - Decadal Survey on Solar and Space Physics 2024-2033 White Papers
  - **Broader community through a series of speakers, panels, and inputs from the public at January 2023 hybrid, open meeting**
- Audience: SWORM, Congress, Space Weather Enterprise

SWAG Report: Finding and Recommendations

Findings and Recommendations to Successfully Implement PROSWIFT and Transform the National Space Weather Enterprise

www.weather.gov/swag



Background

- SWORM has made significant progress over the last nine years to build awareness and move the Nation towards space weather resilience
- Technology, infrastructure systems, and national priorities continue to evolve–with the space domain becoming increasingly important to national and economic security

Broad Set of Space Weather Topics Covered

- Overarching Recommendations
- Ground-Based and Airborne Sensors and Networks
- In-Space Architectures and Space-Based Observations
- Data and Computing Infrastructure for Space Weather Operations
- Improving Benchmarks, Metrics, and Scales for Space Weather End-Users
- Space Weather Risk to Evolving Infrastructure Systems and Services
- Economic Assessments on The Costs of Space Weather and the Value Of Forecasting and Mitigation
- Promote Focused and Continued Engagement Across Industry and Government Space Weather Stakeholders
- Additional Findings and Recommendations
- Next Steps

Priority Recommendations

1. Fund the Federal Space Weather Enterprise. (R.1.1.)
2. Create and fund an applied research program office for space weather within NOAA to coordinate, facilitate, promote, and transition applied research across the national space weather enterprise. (R.2.1.)
3. Ensure OSTP staffing and White House led prioritization and coordination across the national space weather enterprise. (R.3.1. and more)
4. Protect space weather sensors from spectrum interference. (R.5.1.)
5. Provide long-term support for operational ground-based and airborne sensors and networks. (R.6.2.)
6. Provide and fund critical operational space weather services beyond near-Earth. (R.9.2.)

Priority Recommendations

7. Fund NASA missions that advance fundamental science to support space weather research. (R.10.1.)
8. Coordinate benchmark development or improvement with industry. (R.14.1.)
9. Quantify the societal benefits for addressing risk from space weather by performing national-level and industry-wide economic assessments and consider space weather in the context of broader national risk (R.18.1. and R.4.1.)
10. Support coordinated applied research within the thermosphere (above 100 km altitude) which is critical for space traffic coordination. (R.24.1-3.)
11. Foster and lead a global space weather enterprise. (R. 25.1-4)

Ground-Based and Airborne Sensors and Networks

R.6.1. Assess and publish the prioritization of ground-based and airborne sensors needed for current and future space weather products.

R.6.2. Provide long-term support for operational ground-based and airborne sensors and networks.

R.6.3. Fund the transition of NSF research sensors and networks to operations.

R.6.4. Coordinate support for ground-based and airborne sensors and networks that are essential to space-based missions.

Ground-Based and Airborne Sensors and Networks

R.7.1. Expand the use of CRADAs to improve collaboration across the academic and commercial sectors.

R.8.1. Prioritize the addition of underutilized, existing real-time magnetometer data streams over new MT survey campaigns.

Improving Benchmarks, Metrics, and Scales for Space Weather End-Users

R.14.1. Coordinate benchmark development or improvement with industry.

R.14.2. Promote industry participation in workshops and meetings to inform the mitigation of space weather hazards.

R.14.3. Use multiple approaches to validate benchmarks.

R.15.1. Identify and prioritize the development of key space weather metrics.

R.15.2. Update and expand NOAA space weather scales.

R.15.3. Maintain historical space weather indices.

Next Steps for SWAG

- **Engage SWORM agencies** and other relevant stakeholders on these findings and recommendations
- **Engage Congress** on this report, as well as opportunities to monitor and assess SWORM's implementation progress
- Provide additional **input on resilience focused activities** and other needs of end users in the forthcoming results of the user-needs surveys
- **Look into any issues** in more detail as requested by SWORM

THANKS!

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BACKUP SLIDES

Background

- 2015 and 2019 National Space Weather Strategies
  - Community input was via a Request for Information
  - Community didn’t feel it was an all of community activity
- Congress heard you - Enter SWAG
  - Chartered to advise SWORM
  - Members from academia, end-users, and commercial space sectors
  - Representatives of our communities
    - Expected to reach into our communities to get input

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2. Create and fund an applied research program office for space weather within NOAA to coordinate, facilitate, promote, and transition applied research across the national space weather enterprise. (R.2.1.)
3. Ensure OSTP staffing and White House led prioritization and coordination across the national space weather enterprise. (R.3.1. and more)
4. Protect space weather sensors from spectrum interference. (R.5.1.)
5. Provide long-term support for operational ground-based and airborne sensors and networks. (R.6.2.)
6. Provide and fund critical operational space weather services beyond near-Earth.

Priority Recommendations

7. Fund NASA missions that advance fundamental science to support space weather research. (R.10.1.)
8. Coordinate benchmark development or improvement with industry. (R.14.1.)
9. Quantify the societal benefits for addressing risk from space weather by performing national-level and industry-wide economic assessments and consider space weather in the context of broader national risk (R.18.1. and R.4.1.)
10. Support coordinated applied research within the thermosphere (above 1000 km altitude) which is critical for space traffic coordination. (R.24.1-3.)
11. Foster and lead a global space weather enterprise. (R. 25.1-4)

Overarching Recommendations

Funding the implementation of PROSWIFT

R.1.1. Fund the Federal Space Weather Enterprise.

Enabling NOAA to achieve their space weather priorities and accomplish their space weather mission

R.2.1. Create and fund an applied research program office for space weather within NOAA to coordinate, facilitate, promote, and transition applied research across the national space weather enterprise.

R.2.2. Develop internal NOAA strategies to ensure agency-wide coordinated implementation of PROSWIFT and their national space weather policy responsibilities – both overall and within each service office.

R.2.3. Expand NOAA R2O2R functionality to enable the transition to full operations.

Overarching Recommendations

Ensuring coordination of space weather across the Federal Government

R.3.1. Ensure OSTP staffing and White House led prioritization ansd coordination across the national space weather enterprise.

A national risk register

R.4.1. Consider space weather in the context of broader national risk.

Protecting space weather sensors from spectrum interference

R.5.1. Protect space weather sensors from spectrum interference.

Ground-Based and Airborne Sensors and Networks

R.6.1. Assess and publish the prioritization of ground-based and airborne sensors needed for current and future space weather products.

R.6.2. Provide long-term support for operational ground-based and airborne sensors and networks.

R.6.3. Fund the transition of NSF research sensors and networks to operations.

R.6.4. Coordinate support for ground-based and airborne sensors and networks that are essential to space-based missions.

Ground-Based and Airborne Sensors and Networks

R.7.1. Expand the use of CRADAs to improve collaboration across the academic and commercial sectors.

R.8.1. Prioritize the addition of underutilized, existing real-time magnetometer data streams over new MT survey campaigns.

In-Space Architectures and Space-Based Observations

R.9.1. Revise the National Space Weather Strategy and Action Plan to broaden service coverage of additional space environments.

R.9.2. Provide and fund critical operational space weather services beyond near-Earth.

In-Space Architectures and Space-Based Observations

R.10.1. Fund NASA missions that advance fundamental science to support space weather research.

R.10.2. Use a coordinated approach to develop and deploy missions that advance fundamental science supporting space weather.

R.10.3. Establish O2R traceability in the NASA mission formulation process.

R.10.4. Develop a prioritization of space-based sensors to enhance space weather products.

In-Space Architectures and Space-Based Observations

R.11.1. Opportunistically deploy more space weather sensors.

R.11.2. Fly space weather particle sensors on every U.S. Government procured space vehicle.

R.12.1 Sustain resilient approaches to ensure continuity of in-space, operational space weather observations.

Data and Computing Infrastructure for Space Weather Operations

R.13.1. Fund, formalize, and expand the NOAA space weather prediction testbed.

R.13.2. Improve access to space weather data

R.13.3. Improve interagency coordination of models and data.

R.13.4. Promote and prepare for the use of AI/ML algorithms as a complement to traditional empirical and physics-based models.

R.13.5. Continue to identify and release novel and underutilized data sets that improve space weather products.

R.13.6. Promote career pathways for interdisciplinary technologists supporting the space weather enterprise.

Improving Benchmarks, Metrics, and Scales for Space Weather End-Users

R.14.1. Coordinate benchmark development or improvement with industry.

R.14.2. Promote industry participation in workshops and meetings to inform the mitigation of space weather hazards.

R.14.3. Use multiple approaches to validate benchmarks.

R.15.1. Identify and prioritize the development of key space weather metrics.

R.15.2. Update and expand NOAA space weather scales.

R.15.3. Maintain historical space weather indices.

Space Weather Risk to Evolving Infrastructure Systems and Services

R.16.1. Develop an enduring process to understand evolving infrastructure needs.

R.16.2. Leverage industry assessments and applications of magnetotelluric data and geomagnetically-induced current data to improve Earth conductivity models and geomagnetically-induced current assessment tools.

R.17.1. Promote the development of vulnerability assessments by sector owners and operators.

R.17.2. Prioritize addressing space weather risks in sectors other than electric power and aviation.

R.17.3. Address interdependencies of and cascading risks to critical infrastructure.

Economic Assessments on the Cost of Space Weather and the Value of Forecasting and Mitigation

R.18.1. Quantify the societal benefits for addressing risk from space weather by performing national-level and industry-wide economic assessments.

R.18.2. Develop and curate data necessary for effective economic assessments.

R.18.3. Broaden the scope of economic assessments.

R.18.4. Engage additional stakeholders for economic assessments.

Promote Focused and Continued Engagement Across Industry and Government Space Weather Stakeholders

R.19.1. Enhance distribution of space weather products.

R.19.2. SWORM should increase transparency by ensuring the publication of foundational documents, studies, and policies.

R.20.1. Develop standing MOUs or MOAs across and between all SWORM agencies.

R.21.1. Develop and implement broader participation in tabletop exercises.

Other Key Recommendations

Assessing and addressing national security risks from space weather

R.22.1. Develop a national security annex or policy on space weather.

Promoting public awareness and education for space weather

R.23.1. Improve public awareness, education, and engagement regarding space weather application effects.

Other Key Recommendations

Critical need for thermospheric density specification to aid operational systems

R.24.1. Support coordinated applied research for the thermosphere (above 100 km altitude) which is critical for space traffic coordination.

R.24.2. Support coordinated R2O2R workshops and testbed activities for space traffic coordination.

R.24.3. Support and encourage new processes for the incorporation of data and observations to characterize the thermosphere (above 100 km altitude) environment.

Other Key Recommendations

Enhancing global engagement

R.25.1. Foster and lead a global space weather enterprise.

R.25.2. Promote Five-Eyes space weather collaborations.

R.25.3. Formalize bi-lateral or multilateral agreements to support coordinated messaging, mutual resilience, and to further the global space weather enterprise.

R.25.4. Participate in and leverage the international standards development relevant to space environment and space weather.