

Development of Benchmarks for Extreme Space Weather Events

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NATIONAL SPACE WEATHER STRATEGY AND ACTION PLAN

March 2019

The National Space Weather Strategy and Action Plan seeks to achieve three objectives, each supported by a set of high-level actions, to enhance the Nation's preparedness for space weather events:

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.

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The emphasis is on preparedness, resilience, and response.



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

- 1. Refine space weather benchmarks that provide quantitative baselines to assess the intensity of space weather events.***
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.
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
4. Identify and assess the effects of frequent and extreme space weather events on operations and missions
5. Assess the cost of space weather effects on the operations and implementation of critical missions.

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What Are Benchmarks?

- * They are not metrics for model or prediction performance
- * They are specifications of extreme space weather conditions
- * The benchmarks specify the 1-in-100 year and theoretical maximum levels of space weather conditions that can affect critical infrastructure
- * They are 'technology agnostic' and do not evaluate or classify the potential effects of a space weather events

What Is the Purpose of Benchmarks?

- * Enhance awareness of threats among critical infrastructure owners/operators
- * Provide input for engineering standards
- * Provide input for vulnerability & risk assessments
- * Help guide development of mitigation procedures
- * Establish thresholds for action
- * Set goals for academic and private sector research



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Federal Departments and Agencies are the end users (customers) for Benchmarks Specific Goals for Action include:

1.2 Assess the vulnerability of priority critical infrastructure systems and national security assets to the effects of space weather

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

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

Objective 3: Establish Plans and Procedures for Responding to and Recovering from Space Weather Events

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E.G. Objective 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.

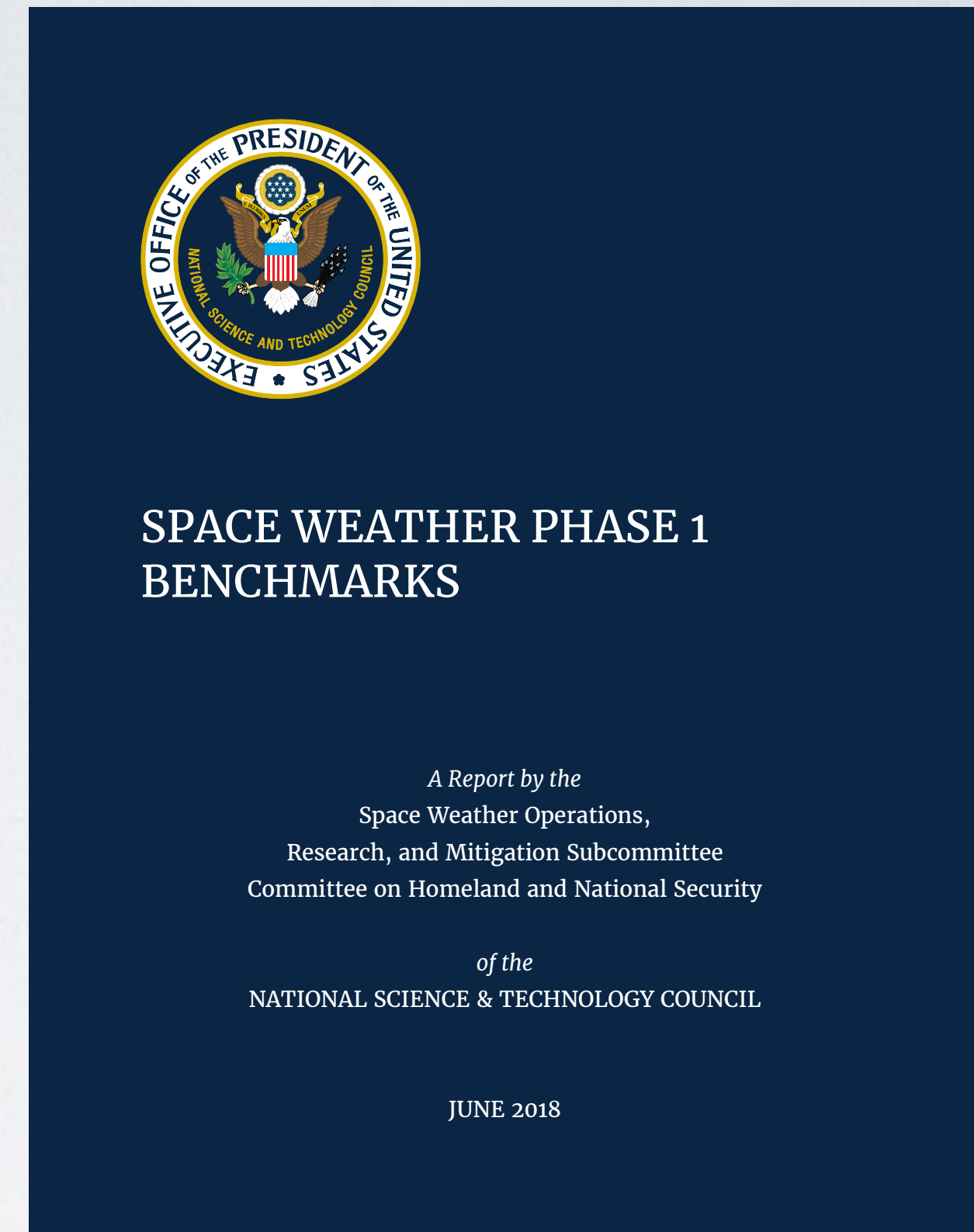
Vulnerability assessments should include interdependencies and failure modes among sectors that could contribute to cascading failures. This action should include assessments of national critical functions and associated priority critical infrastructure and national security systems, assets, and networks, representative of those deployed across the globe and in space.

Who is this action directed at?

Mid-term; DHS, DOC, DOD, DOE, DOI, DOT, Environmental Protection Agency (EPA), Department of Health and Human Services (HHS), Department of Treasury (Treasury), DOI, and Nuclear Regulatory Commission (NRC)

Phase I Benchmark Study

- * Begun in 2017
- * Published in 2018
- * Conducted by the Space Weather Operations, Research, and Mitigation (SWORM) subcommittee
- * Under the US Department of Homeland Security
- * Involved >25 federal departments and agencies



Working Toward Phase 2

- * The 'Next Steps' panel conducted an in depth review of the Phase 1 benchmarks and methodologies
- * Also provided recommendations for research and development of improved benchmarks
- * Assessment and recommendations report published in Dec. 2019
- * Note: the NSW Strategy & Action Plan calls for benchmarks to be reassessed at least every 5 years. $2018 + 5 = 2023$

Next Steps Space Weather Benchmark Study

Conducted January-November 2019

Geoff Reeves, Chair
Thomas J. Colvin, Executive Secretary
Jericho Locke, Executive Secretary

Induced Geo-Electric Fields

Pete Riley, Leader
Jeff Love
Antti Pulkkinen
Adam Schultz
Emanuel Bernabeu
Alan Thomson

Ionizing Radiation

Christina Cohen, Leader
Joe Giacalone
Therese Moretto Jorgensen
Juan Rodriguez
Tim Guild
Delores Knipp

Ionospheric Disturbances

Susan Skone, Leader
Anthea Coster
Keith Groves
Jonathan Makela
Ethan Miller
Roger Varney

Solar Radio Bursts

Dale Gary, Leader
Tim Bastian
Gregory Fleishman
Stephen White
Angelos Vourlidas
Jade Morton
Jasmina Magdalenic

Upper Atmosphere Expansion

David Jackson, Leader
Sean Brunisma
Yue Deng
Eric Sutton
Tzu-Wei Fang
John Emmert

We Answered the Following Questions, Identified Gaps, & Made Recommendations

- * Are the current benchmark quantities well-aligned with the objectives and use cases stated in the Phase I Document?
- * Are the benchmark values reasonable and up-to-date based on current understanding? (data, models, and gaps)
- * Is the methodology used to derive the benchmark values up-to-date, rigorous, and compelling?

General Conclusions

- * The Phase I benchmark panel did an amazing job in a short amount of time
- * In general the Phase I benchmark quantities are: well-aligned with the objectives and use cases but we provided recommendations for other quantities that could enhance the value and/or utility of the benchmarks for end users
- * The benchmark values are mostly reasonable and up-to-date but we recommended some updates, identified some important gaps, and made recommendations for refining and improving the benchmark values
- * Some of the methodology used were up-to-date, rigorous, and compelling but we identified some gaps and made recommendation for other methodologies that should be considered in development of improved benchmark values.

Cross-Cutting Issues

- * We recommend that, in addition to 1-in-100 year and worst case, developing 1-in-N year benchmarks would add value, confidence and utility (i.e. one-in-20 or 1-in-50 year events) Also links to NOAA scales
- * Benchmarks would benefit from a dedicated data collection plan prioritizing both data continuity and new data sources
- * Capturing duration along with intensity of events would enhance their usability and value

We Made Near and Long-Term Research Recommendations

- * The committee recognizes that improving the space weather benchmarks represents a new direction for the research community and for research funding agencies
- * The goals of improving benchmarks are aimed more at quantification and less at basic physical understanding than past activities (but not mutually exclusive)
- * Benchmark-focused research will require non-traditional research investments including: cleaning data sets to remove artifacts; cross-calibration of heterogeneous data sets; making data sets more publicly available, etc.
- * Benchmark-focused research will require development of models aimed specifically at long-term analysis and/or prediction of extremes

Specific Recommendations for New Directions in Research Funding

- * The panel recommends that research funding agencies, such as NASA and NSF, implement new research programs that directly address the unique applied research demands of improving space weather benchmarks.
- * The panel also suggests that research funding agencies also consider how research priorities in modeling might more effectively advance physical models with the goal of understanding long-term and extreme space weather conditions.

What Can the Roundtable Do?

- * Solicit updates, plans, and timeline from the organizations responsible for producing the Phase 2 benchmark (i.e. get the ball rolling again)
- * Offer our services to departments and agencies as they implement the actions needed to assess vulnerability and develop resilience plans
- * Initiate dialog to help educate and support those departments and agencies who are responsible for the actions called for in the SWx Strategy & Action Plan