# NATIONAL SPACE WEATHER PARTNERSHIP

# 2017 SPACE WEATHER ENTERPRISE FORUM

# EXECUTIVE SUMMARY

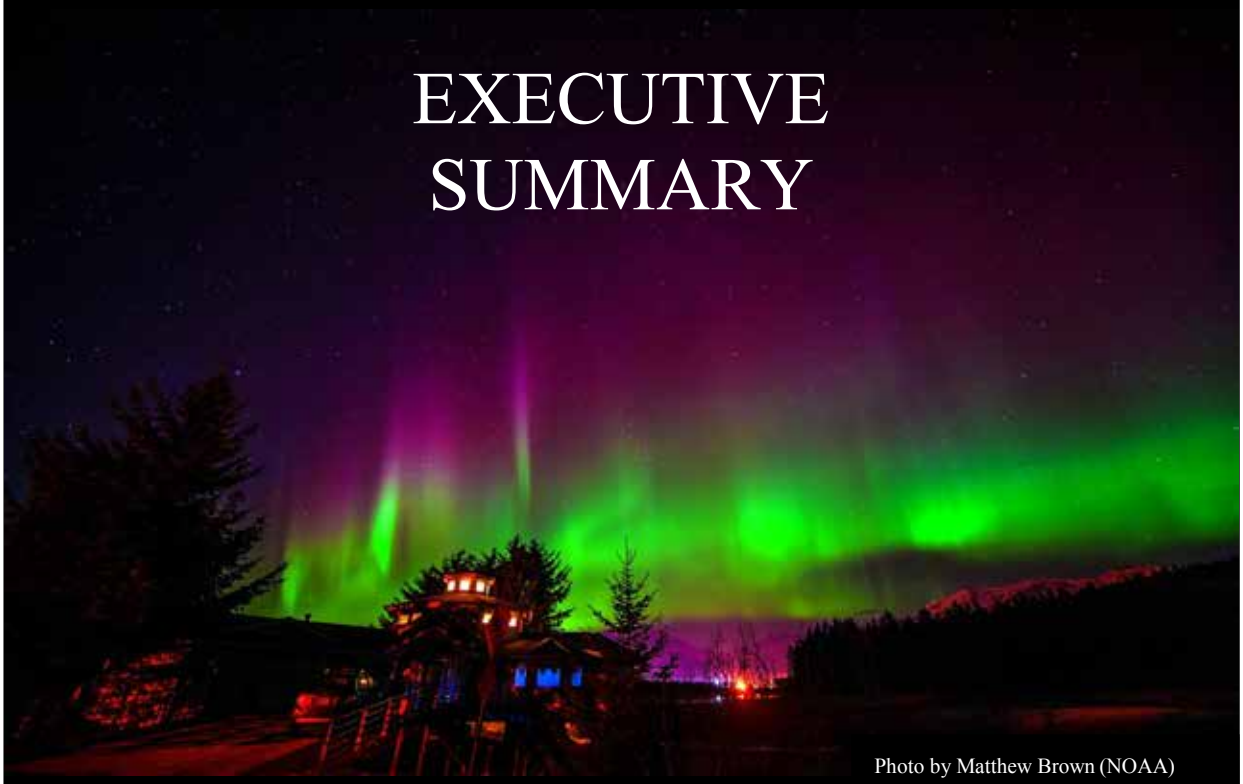

Photo by Matthew Brown (NOAA)

Note: Speaker and audience remarks are paraphrased and not to be used as quotations.

# 2017 SPACE WEATHER ENTERPRISE FORUM SUMMARY

This document provides a synopsis of the 2017 Space Weather Enterprise Forum (SWEF)—an event sponsored by the National Space Weather Partnership and hosted by Mr. Ralph Stoffler, Director of Weather, US Air Force. This year's theme was "Implementing a National Space Weather Partnership."

**Meeting location: The National Transportation Safety Board Conference Center at L'Enfant Plaza, Washington, DC.**

## Motivation

In the past few years there has been substantial progress in understanding the potential impacts of space weather to the technological infrastructure that underpins modern society. National policy decisions regarding the capabilities to prepare for and respond to space weather impacts have established a solid foundation to prepare for inevitable space weather events in the future. The peak of the most recent solar maximum provided clear evidence of the potential disastrous effects that can result from severe space weather. This year, the Space Weather Enterprise Forum explored the effects of High Impact, Low Frequency events and the plans for preparedness, mitigation and response.

## The Forum

The Space Weather Enterprise Forum brought together the space weather community to share information and ideas among policymakers, senior government leaders, researchers, service- provider agencies, private-sector service providers, space weather information users, media, and legislators and staff from Capitol Hill to raise awareness of space weather and its effects on society. The outreach continued this year, but the focus was sharpened on critical infrastructure protection, with the necessary underpinnings of research, improved products and services, and applications to serve a broad and growing user community. The ultimate goal is to improve the Nation's ability to prepare for, avoid, mitigate, respond to, and recover from the potentially devastating impacts of space weather events on our health, economy, and national security.

## Forum Objectives

- Explain how space weather science and infrastructure benefits the public.
- Discuss vulnerabilities of our technological infrastructure to space weather impacts.
- Report on the status of the National Space Weather Strategy, Action Plan, and Executive order to improve national space weather capabilities.
- Examine roles and partnership opportunities between the government, commercial, and academic stakeholders.

## Format:

A panel format was used, which included presentations by the expert panelists followed by time for questions from a diverse group of attendees. The agenda was developed by the interagency SWEF Organizing Committee. Forum presentations can be found at: http://www.ofcm.gov/meetings/SWEF/swefmeeting.htm.

## Forum Sponsors

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The National Space Weather Partnership organized the 2017 SWEF through the Office of the Federal Coordinator for Meteorological Services and Supporting Research (OFCM). The United States Air Force provided the financial support for this year's forum. The Secure World Foundation provided hospitality funding as well as audio and written transcripts of the event which are available online at: https://swfound.org/events/2017/space-weather-enterprise-forum.

**Session 1: Opening and Welcoming**

The Opening session consisted of welcoming remarks and introductions by **Mr. Ralph Stoffler,** Director of Weather, Deputy Chief of Staff for Operations, Headquarters, U.S. Air Force, Washington, D.C; a National Security Perspective by **Major General Scott Vander Hamm**, Assistant Deputy Chief of Staff, Operations, Headquarters U.S. Air Force, the Pentagon, Washington, D.C; and a Government Perspective by **Dr. Stephen Volz**, Acting Assistant Secretary for Environmental Observation and Prediction, National Oceanic and Atmospheric Administration (NOAA).

Mr. Stoffler emphasized that as budgets become tight, we need to leverage one another and work together to achieve ultimate success because space weather impacts operations every day. The Department of Defense, in particular the Air Force, feels the impacts of space weather everyday as they conduct combat operations throughout the globe. This is a team effort. We need to start creating a unified framework that facilitates the exchange of information. We know that both NOAA and the DoD have commercial programs in place. Cooperation is getting better all the time, not only with government agencies, but with academia and increasingly with the commercial sector.

Major General Vander Hamm related some of his personal experiences regarding Space weather, particularly, impacts on the long-range strike missions which rely on use of long-haul communications through satellite communications or digital High Frequency radios. In full-spectrum, no-fail missions like the nuclear mission and missions of homeland defense, space weather is vital to the Initial Threat Warning and Assessment and the Nuclear Command, Control and Communications. Strategic miscalculations due to poor situational awareness caused by space weather interference could have serious implications. Operational decisions and execution often rely on timely and accurate space weather data. Space weather has caused air traffic control problems, changes in force alert conditions, impacts on precision-guided missiles and degraded communications for rescue missions. This is why it is important to arm operators with information that will help them understand communication outages that could be affected by space weather. Space is becoming more congested, more contested, and more commercial. It is important to articulate accurately space environmental impacts to operations in the space, air, land, and the sea domains.

Dr. Stephen Volz spoke from an overall government perspective but emphasized the civil and NOAA aspects. He stated that NOAA customers include everyone in the nation, actually everyone in the world, since NOAA services are provided freely and openly. These services include all the varied weather and space weather observations, forecasts and warnings that touch everyone on a day-to-day basis, even though the vast majority of people are not aware of the services NOAA provides.

NOAA's role is to observe, understand, and protect. The environment is observed from the surface of the Sun to the bottom of the ocean, with the various different observing systems. Science, analysis, and modeling are used to understand what those observations mean. Protection or information services are providing actual information to help Americans and others prepare for and respond to consequential and day-to-day environmental events.

Generally, humans are slow to prepare for low probability, high impact events. An event like the 1859 Carrington event could disrupt power distribution to large regions of the United States for months and could have an impact in the economy of more than $1 trillion.

In the last several years, the Administration has focused on space weather readiness with the establishment of the Space Weather Operations, Research and Mitigation (SWORM) effort within the Office of Science and Technology Policy (OSTP). The SWORM Task Force provided a series of six goals in the National Space Weather Strategy and Action Plan to delineate comprehensively we needed to do to address the challenge. As of earlier this month, approximately 80 percent or more of the action items within the Space Weather Action Plan (SWAP) were listed as either on track, submitted, or completed. Completion of these goals will be an important and critical first step in better preparing the nation for space weather events.

There are number of agencies in many foreign governments around the world providing critical observations. The GOES satellites in particular have provided space environmental and solar observations for about 40 years at various levels, from a geostationary vantage point above the earth. The benefit of an operational platform such as GOES is that it provides a baseline that everyone can count on for regular delivery of information. We can rely on these data and use it to advance capabilities in future satellite systems.

Dr. Volz also provided information about deep space weather satellite observations. NOAA understands that observations from L1 are going to be critical in the long-term and has made it a piece of their long-term space-based observation program.

He reviewed the current and planned space weather model being run within the National Weather Service use only about two percent of total computational capacity. New models and capabilities are being developed and implemented. Interagency and public coordination allows users to define their needs for observations and models to support their operations and research that are most beneficial and useful.

**Session 2: Space Weather Impacts and Mitigation**

The panel members provided a variety of interagency perspectives on how the federal government is working with their partners to manage space weather impacts and some of the work that's going on across different agencies in many different areas. The Federal Emergency Management Agency and Department of Energy (DOE) have decided to co-lead the development of a Power Outage Incident Annex that is addressing both response and recovery for the federal interagency operations plans to address a long-term power outage. Since the federal government does not own power transmission lines or power companies, it does not have the ability to maintain or restore power delivery. However, it does have resources and capabilities to be able to assist with life-saving, life-sustaining actions that would help to assist those people who were impacted by power outages. Other governmental assistance could include reinforcing traffic management, public safety, and coordinating services like debris removal.

DOD operates throughout the entire spectrum of preparedness, readiness, and response. It has a set of global missions, operates satellites, ships at sea, and ground forces deployed. DOD has niche products for those mission areas that cover the entire globe. It's a very difficult challenge to meet. The forces need to be able to communicate and have their Global Navigation Satellite System work in order to find and hit their targets while minimizing collateral damage. Assured availability, dedicated communications, and the need for the data to be there when it is needed is very important. DOD weather and space weather sensors are there for very specific purposes. It's not just collecting data or collecting all data, but collecting specific data types to support operational missions. Integration and cooperation with everyone, including international partners and academia, is important as well. DOD is doing its part and is prepared to assist other agencies as required.

DOE transformers are key elements in terms of the potential threat from a Geomagnetic Disturbance (GMD) or an Electromagnetic Pulse (EMP) event. Both could have a considerable impact. DOE relies on National Aeronautics and Space Administration (NASA) and NOAA to advise them and warn the industry when an event is happening. The more specific the information, the better. Manufacturers are working on various initiatives, including lightweight transformers that are separable so they can be moved in different pieces as opposed to a single piece. Transportation of these transformers is a serious concern due to their large size an heavy weight, because of regulatory barriers at the state level, and the availability of the large capacity vehicles to move them over rail or roadways. They're also concerned about the availability of crews to put the transformers into operation. The utility industry has a very long history of sharing personnel resources at the energy co-ops, municipal, and private sector owned companies. They are accustomed to resource pooling and sharing because of their responses to hurricanes, tornadoes, etc.

FEMA noted that there are three types of space weather that we care about and they have different timelines. Radio blackout events (about eight minutes) that cause HF impacts, solar radiation storms (20 minutes) that impact satellite communications, and geomagnetic storms (15 to 20 hours) that affect L band-GPS communications, In addition, the intensity and the magnetic variations change throughout a solar storm. FEMA has discovered that seven days is about what people can manage without a whole lot of extra help. Communities are very resilient up to about seven days. After seven days is when it starts to get challenging. From a preparedness mitigation perspective, one of the good things about space weather is that it's a natural hazard like a lot of other natural hazards. That means that the things that you do to prepare for hurricanes, tornadoes, earthquakes, and volcanoes are the same things you would be doing to prepare for space weather. A lot of this preparation is described at Ready.Gov; for individuals, it will tell you what supplies you need to keep in your home.

**Session 3: Space Weather Services, Science, and Supporting Infrastructure**

The Session 3 panel consisted of a Moderator and four speakers covering cover space weather services research from both a government and commercial perspective. For decades NASA has pushed the envelope of solar and space science. NASA's approach to space weather consists of fundamental research, innovative observing architectures, and integrated modeling. The Magnetospheric Multiscale mission is currently providing key insight into the fundamental physics of magnetic reconnection on all scales. The NASA

heliophysics observatory includes more than a dozen spacecraft missions throughout the near and deep space to provide key data for both research and operational use. A suite of over 80 models running at the Community Coordinated Modeling Center are helping the science community understand the nature and processes of the space environment.

The National Science Foundation (NSF) has long history in supporting the advancement of solar and space science from basic processes to specific space weather effects. They strongly support interagency coordination and public outreach and education. NSF supports cutting edge observing systems of the sun, ionosphere, and magnetosphere. They have been a key facilitator for the development of cubesat capabilities space science. Along with NASA, NSF plays a key role in the development of space weather modeling through the Community Coordinated Modeling Center (CCMC) and other funding activities.

NOAA provides the definitive source of space weather information and service for civil applications. The NOAA Space Weather Prediction Center collects data from all freely accessible sources and provides a wide variety of products and services to an ever-increasing customer base. NOAA provides leadership and is a strong supporter of the SWORM Subcommittee, and is tasked with numerous actions from the Space Weather Action Plan. These actions are focused mainly in space weather observation, services, transition of research to operations and operations to research feedback. However, they also underpin all of the other aspects of the SWAP. NOAA space weather activities are included in the all-hazard Weather Ready Nation initiative. Forecasting space weather will advance through: new and sustained observations, advances in space science understanding and research, improved/accurate numerical prediction models, and the transition to operations: improved models and post-processing through effective Research-to-Operations/Operation-to-Research (R20/O2R) collaboration. These actions, along with an understanding of user needs, will enable NOAA to serve users/partners with consistent, accurate, and actionable information.

Vice Admiral (ret) Conrad Lautenbacher provided interest insight from the commercial space weather sector. He discussed key aspects of the National Space Weather Enterprise, including possible strategies, components of the space weather community, partnership opportunities, and progress being made. He described the challenges to the community under a constrained budget environment. Finally, described the American Commercial Space Weather Association and specific capabilities resident within its corporate members.

**Session 4: National Space Weather Strategy and Action Plan Update**

In November 2014, the Chair of the National Science and Technology Council (NSTC), on behalf of the President of the United States, chartered the interagency SWORM Task Force (later Subcommittee). The Task Force developed a National Space Weather Strategy that articulated high-level strategic goals for enhancing our Nation's preparedness for severe space weather events and the SWAP to implement direction from the strategy**.** Over the past two years a national strategy and action plan for space weather were developed in recognition of the reliance on advanced technology. A progress summary on the six strategic goals showed 75% or more of the goals accomplished. There is increased interest and an increased number of forums to work with international partners, because this truly is not just a national effort. It is a global effort because space weather can hit anywhere on the globe at any time. SWAP Goal One is to develop 1-in-100-year metrics of extreme events. Benchmarks have been developed for induced geoelectric fields, ionizing radiation,

ionospheric disturbances, solar radio bursts, and upper atmosphere expansion. There is another international activity where the US, Russia, China, Europe, India, and Japan, and the United States have a committee on global navigation satellite systems. They have agreed on common signals and agreed on common principles, on transparency, and interoperability on the civilian side. Efforts are underway now to standardize the space-weather processes.

**Session 5: The National Space Weather Partnership**

This session explored existing and potential avenues of cooperation between industry, academia, and government to advance space weather science, improve services and enable better preparedness and mitigation efforts within the nation. There are fundamental, basic science questions that must be solved, but they need to be applied to have impact, and then to feed back to the basic science. Advantages of the American Commercial Space Weather Association include corporate memory, expertise in specific technical areas, regional expertise, customer-oriented priority setting, cost effective and agile partnering, whether agile partnering is business to business, agency, or a combination. A commercial satellite platform at L1 or up to Sun-Earth line which combines multiple users can meet NOAA's requirements at the lowest cost while maintaining the inherently governmental function of solar monitoring and warning. There is substantial evidence that commercial providers could take on the risk of building, launching, and operating a mission to meet NOAA's requirements. Multiuser platforms reduce cost to the government. The increasing reliance upon systems that are subject to space weather is the beginning of a robust economic sector that can and is being led by the US. It is a global challenge, which means there are global opportunities.

**Session 6: Summary and Wrap-up**

Dr. William Schulz: Director, Office of the Federal Coordinator for Meteorology: The Space Weather Enterprise is a good news story. This is the second SWEF since SWORM became an official sub-committee and Executive Order 13744 was signed. That means a strong policy foundation exists for the Space Weather Enterprise. There is an increasing awareness among decision-makers in the civil world, the military world, and the commercial world about the effects of space weather. We're not talking just about the high-impact, low-probability events, but the everyday effects on communications and positioning, and effects on aircraft. There is also an impressive amount of interagency and international coordination going on within the Space Weather Enterprise and also tangible international support. One of the best ways we can increase from our current 5 to 20 percent operational space weather capability, a range several presenters described, towards 100 capability is perfecting that R20-O2R circle. It is also important to increase engagement with the commercial sector, which can be effectively done through industry associations, SBIRs and STTRs. There are many opportunities to engage the efficiencies of the commercial sector to move us forward in data observations and collections. There's room to engage in a multi-disciplinary environment, getting specialties that we normally don't associate with space weather into the fold to address some of these challenges. And as noted by several of the State Department speakers, a little bit of investment, wisely deployed around the world, may yield great benefits in terms of data sources that we have not yet tapped into. The bottom line is we need to keep the press on in space weather, and build on the good momentum we have now.

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