

2010 SPACE WEATHER ENTERPRISE FORUM SUMMARY REPORT

This document provides a summary of the 2010 Space Weather Enterprise Forum (SWEF), an event sponsored by the National Space Weather Program Council and hosted by Mr. Samuel P. Williamson, Federal Coordinator for Meteorology, on June 8, 2010, at the National Press Club in Washington, DC.

OVERVIEW

Purpose and Theme: The Space Weather Enterprise Forum brings 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, the media, and legislators and staff from Capitol Hill to raise awareness of space weather and its effects on society. While continuing this outreach, this year we sharpened the focus on critical infrastructure protection, with the necessary underpinnings of research, improved products and services, and applications to serve a broad and growing user community. Our ultimate goal is to improve the Nation's ability to prepare for, avoid, mitigate, respond to, and recover from potentially devastating impacts of space weather events on our health, economy, and national security.

The theme of this year's SWEF was, *Building an Informed and Resilient Society—the Decade Ahead*. As we approach the next peak of solar activity expected in 2013, our Nation faces multiplying uncertainties from increasing reliance on space weather-affected technologies for communication, navigation, security, and other activities, many of which underpin our national infrastructure and economy. We also face increased exposure to space weather-driven human health risks as trans-polar flights and space activities, including space tourism, increase.

With strong partnerships built over the years, approximately 230 people from the Federal government and the military (49 percent), industry (33 percent), the research and academic communities (13 percent), and international stakeholder agencies (5 percent) participated in the forum. All of the presentations that were given at the 2010 SWEF and supporting material can be found at: http://www.nswp.gov/swef/swef_2010.html.

Objectives: The Opening Session and five other sessions that were held during the one-day forum were structured to address the following objectives:

1. Share information across the enterprise and raise awareness for new users, decision-makers, and policymakers.
2. Identify effective approaches to raise awareness in the broader society.
3. Identify effective approaches to build resilience across society, particularly in critical infrastructure protection and support.
4. Improve communication within and external to the enterprise.
5. Collect information to support a new National Space Weather Program Implementation Plan.

Forum Outcomes: The results and findings from the 2010 SWEF are summarized below and will serve as input to the new National Space Weather Program Implementation Plan.

- The potential impacts of space weather are not widely known or understood by the public; however, our Nation is beginning to recognize that space systems are important to our daily lives and potential threats exist.
 - Social science research shows that the average citizen has a 10th-grade understanding of science and that most of their information comes from the media. As a result, we must continue to pursue public outreach and education efforts with the help of the social science community.
 - The public relies on the government to provide services to protect them from environmental impacts.
 - Due to our heavy reliance on a technical and space-enabled infrastructure, there is virtually no aspect of our lives that is not affected by space weather.

- We are not ready for an extreme space weather event, and our ability to cope with routine impacts is modest.
 - We must develop a better, more specific, more reliable prediction and warning capability to enable government and civil leaders to make informed decisions.
 - Since it is very difficult to prepare for low-frequency/high-impact events like an extreme solar event, which would cause a major disruption of the power distribution grid, plans need to be developed and exercised in order to improve disaster response, impact reduction, and the resiliency of our society.
 - It is also important to not overemphasize the very rare/extreme impact events and fail to address the more routine impacts. An extremist approach will lose emphasis and support while we wait for “the big one.”

- The National Space Weather Program has been very successful over the years in fostering cooperation among agencies, encouraging public outreach and education, and advancing the science, but much work needs to be done to improve the research to operations chain, and operational services.
 - The community has had a very good year with several significant achievements including: the launch of Solar Dynamics Observatory (SDO), the support for the Deep Space Climate Observer (DSCOVR) solar wind monitoring mission, the initiation of a Decadal Survey for space environmental science, and the publication of the Subcommittee on Disaster Reduction (SDR) Space Weather Implementation Plan.
 - We must work to secure launch of DSCOVR at the earliest opportunity and establish a long-term solution for solar wind monitoring.
 - We need to investigate the release of available and useful classified data sets to the space weather research community.
 - We need to further define the operational requirements for space weather products and services; e.g. trans-polar flights and extreme solar events.
 - We must continue to support space weather research and development, develop the research-to-operations (R2O) chain, and move new and improved space weather forecast models into operations.

- We are beginning to recognize and expand our interaction and collaboration with international and foreign organizations possessing and developing important space environmental science and space weather capabilities.
 - The forum clearly highlighted the mutual benefits that could be realized by improving international cooperation.

FORUM SYNOPSIS

Sessions Conducted:

1	Welcome and Opening Addresses
2	A Year Moving Forward – The National Space Weather Program
3	The Future of Space Weather Science and Research Transition to Operations
	Lunch speaker
4	International Activities and Cooperation
	Featured Speaker
5	Critical Infrastructure Support
6	Summary and Wrap-Up

Media Coverage: The 2010 SWEF was attended by several print and internet reporters and a video crew from the Associated Press. Coverage included on-camera interviews with Dr. Richard Fisher (National Aeronautics and Space Administration (NASA)), Dr. Dan Baker (University of Colorado), and Mr. Samuel Williamson (OFCM). The press releases from the National Oceanic and Atmospheric Administration (NOAA) and NASA generated numerous telephone interviews conducted by the American Broadcast Company and "The Morning News with Bruce Kenyon" on CHQR radio in Calgary, Alberta. Quotes from these interviews and reports on the SWEF made front page headlines on FoxNews.com, Yahoo.com, and countless other outlets. An internet search conducted one week after the SWEF returned over 44,000 inquiries/"hits" related to the phrase "Space Weather Enterprise Forum 2010."

Session 1: Welcoming and Opening Addresses

- Welcoming Remarks: **Mr. Samuel P. Williamson**, Federal Coordinator for Meteorological Services and Supporting Research

Mr. Williamson welcomed the audience, gave an overview of the 2010 SWEF agenda and goals, and introduced the Opening Keynote speaker.

- Keynote Speaker: **The Honorable Donna F. Edwards (D-MD)**.

Representative Edwards is from the 4th U.S. Congressional District which includes NASA Goddard Space Flight Center and NOAA's offices in Silver Spring, MD. She told the audience she understands the importance of these agencies and their missions which span a wide range of activities. She also gave credit to both NASA and NOAA for using their satellite assets to provide high quality photos and intelligence for high impact events like the Gulf oil spill.

Representative Edwards described space weather as a niche area, with today's society highly dependent on space-enabled infrastructure and systems. Although we understand the impacts of space weather can be significant, she thought the broader public has very little knowledge of the science or its importance. She described space weather as having similar effects as terrestrial weather in that both have daily effects that go unnoticed and both have severe, low-frequency/high-consequence events with potentially global impacts. Representative Edwards noted that space weather is one of the really complex issues related to space, and that society is looking to the government and the research community for solutions to these complex issues as we plan for the future.

From a policy perspective, decision makers must define the scope of the resources needed to address the threat. Gathering data for a rare event (low frequency/high consequence), like an extreme geomagnetic storm, presents a major challenge. We need to consider the impacts on our complex world, to include national security assets like those engaged in Afghanistan and Iraq.

In closing, Representative Edwards noted that, although we are in a tough budget year, the current administration strongly supports science, technology, and research. She mentioned that we are at a critical point in science and technological development and that she needs help from across the agencies to support budget development and to connect the research needed for space weather with our national interests.

- Invited Speaker: **Mr. Christopher J. Scolese**, NASA Associate Administrator.

Mr. Scolese noted there are many uncertainties as we approach the next solar maximum. He pointed out that, although this has been a very “low” solar minimum, it has produced some rather unexpected affects. The flux of cosmic rays at Earth, which are modulated by the strength of the solar wind, has hit an all-time high. Exposure to cosmic rays and solar events limits the career of astronauts. Ionospheric and neutral atmosphere density has been so low that orbital debris, normally removed over the course of a solar cycle, has remained in orbit longer, increasing the potential for collisions.

Understanding and predicting space weather is critical to human activity. He stated that almost no aspect of human life is unaffected by space weather due to our dependence on space systems and technologies affected by the space environment. Space weather fundamentally affects all NASA missions and operations, and although we currently need forecasts of days to weeks to support our space activities, as manned spaceflight moves out beyond the near-earth environment, we will need forecasts of months to years.

Mr. Scolese went on to describe NASA’s evolving Heliophysics System Observatory, the Solar Terrestrial Relations Observatory (STEREO), and the Solar Dynamics Observatory (SDO) spacecraft. He noted that STEREO and SDO are providing great data and urged the community to pursue the hard theoretical work to help us improve our understanding of space science. Using this as a solid foundation, we need to transition science discovery into operational applications, and continue to ensure data availability from current and future sources. In summary, Mr. Scolese said NASA is committed to invest more in space weather and to do the research needed to improve both our understanding of space weather and our operational capability.

Featured Speakers

- Lunch Speaker: **Mr. Jay Reich**, Deputy Chief of Staff, U.S. Department of Commerce.

Mr. Reich stated that the President Obama’s administration is committed to science, technology, and research, and that he feels privileged to sit at the intersection of science and policy. He discussed how space weather touches NOAA’s organizational themes of Workforce Excellence, Organizational Excellence, Economic Growth, and Science and Information. Mr. Reich said we need to answer three questions when dealing with low-frequency/high-impact events, like a large geomagnetic storm—how serious is this problem, how do we judge the probability, and how do we “avoid it”? He explained that since the

work of scientists needs to be translated for use by the policy makers and the public, he proposed using social scientists to help communicate the risks of and need for space weather services. He also pointed out that science is a slow, deliberate, and data based process which is unfortunately often too slow for policy and political decisions.

Comments, Questions and Answers

1. (Q) What do we need to do to not only to be prepared, but also to be resilient. How does preparedness translate to resiliency to survive, recover, and reconstitute?
(A) Mr. Reich was not suggesting preparedness as opposed to resiliency. He mentioned that FEMA was developing a national response to emergencies so that any action is not ad hoc. He views resiliency as a part of preparedness. Part of being prepared is being able to survive and how to build critical infrastructure and prepare an immediate response.
2. (Q) Can social scientists match science issues with policy?
(A) A tough problem. The public wants short-term solutions. Scientists must realize there is a communications challenge and must work with the social scientist to deliver the message. Our focus has to be on customer service, and there needs to be better cross-fertilization among the social science and scientific disciplines.
3. (Q) How do you sustain a national policy in the context of the public's need for short-term gratification (and a 1-year budget cycle) with the long-term scientific needs.
(A) Mr. Reich stated that you cannot deny the communications challenge, and you must also think about the delivery of the message. You must design the research and its publication to what the consumer needs. This will help the Office of Management and Budget support it and make the work more valuable. This is challenging in the 24/7 press cycle. He asked the group if there were any fellowships available to get scientists into journalism programs.
4. (Q) Regarding the oil spill, if there were any lessons learned from the Exxon Valdez and how many major oil spills will it take?
(A) Mr. Reich commented that the Exxon Valdez was not the same as the BP oil spill. The Valdez was a finite amount of oil. We did improve command and control but were not rigorous in the follow-up. Lessons were learned but not applied consistently.
5. (C) There are very few places for scientists to write in the public domain. Many of the traditional venues have been lost.
(A) Mr. Reich stated that readers still want to read the information, but we have to adjust to the new communications modalities. Traditional sources are not as popular, and we have to adjust.

- Featured Speaker: Mr. W. Craig Fugate, Administrator, Federal Emergency Management Agency (FEMA)

Mr. Fugate described FEMA's interest in space weather by pointing out that FEMA must be able to deal with the consequences of events. The impacts of space weather events could potentially have hemispheric repercussions, and we need to determine when the public begins to be impacted and identify unknown interdependencies. He likened space weather to the Y2K threat at the turn of the century, in that (1) interdependencies are not well known, (2) events would have potential widespread impacts, and (3) our ability to mitigate the impacts depends on advanced knowledge.

Mr. Fugate gave FEMA poor grades for our preparedness for catastrophic space weather events. The risk is increased because the electrical transformers and control systems for the

national power grid are not produced in the U.S., causing potential global competition and conflicts for replacement. Additionally, we do not know how many systems use the global positioning system (GPS) timing signals to synchronize operations. This could cause widespread disruptions to a broad range of systems. Our growing reliance on mobile communications is also creating unknown interdependencies. For an extreme space weather event, normal tools won't be available due to the scale and size of the potential failures.

FEMA conducted a disaster response exercise using the extreme space weather event scenario, to help generate questions and discussion. They found that there was little knowledge of existing space weather products or how to use them, but the exercise helped raise the level of awareness of space weather services. They also found that the Space Weather Scales impact categories are useful, but they don't adequately describe higher level events. He said the Nation needs to reposition assets, particularly satellites, to get the longest lead time possible. In the past, systems have been fairly resistant to space weather impacts, but newer technologies have not been "tested" through a solar max. Space weather poses a natural hazard that impact systems, with consequences for their failure. The FEMA exercise was illuminating, but we need to ask and address the tough questions so that we can build resiliency into our systems. We must look beyond detecting and monitoring events to looking at mitigation options and strategies. In order to address the question of who makes the executive decisions to protect the infrastructure, he plans to conduct a Cabinet-level exercise to develop a game plan. These decisions have dramatic consequences on the public, and we are not ready. We need better data, longer warnings, and better impacts to communicate to decision makers. In the end, we want space weather to be an event, not a catastrophic disaster!

Comments, Questions and Answers

1. (Q) How much lead time do the decision makers need to make a coordinated, actionable decision?
(A) Mr. Fugate would throw the question back to the science community, asking what's possible. Decision makers need as much lead time as possible.
2. (Q) Has FEMA has gotten far enough to consider the length of lead time compared to accuracy?
(A) Mr. Fugate answered that current hurricane accuracy is 10-15 percent. Lead time depends on what can be done, the lead time to act, and the time needed to make an effective, coordinated decision. Currently, we can detect events, but impacts are problematic. He suggested a watch/warning system similar to the terrestrial weather system, but we need to determine the appropriate lead time for action and the art of the possible with the current science. Failure to make a decision becomes a decision.
3. (Q) Is FEMA supporting NOAA's and NASA's budget, regarding space weather?
(A) Yes. In addition, FEMA has designated its region headquarters in Denver to become the subject-matter experts on space weather events.
4. (Q) What is the process to move forward—would FEMA lead, or the scientific community?
(A) FEMA is ready to use forecast products and tools available at SWPC. What is available and what can we do? If FEMA can't understand and use the products, then how do we work with the states? FEMA would like to hold a deputies or principal-level exercise to identify vulnerabilities. It is not clear who would lead, who would have responsibilities for communications and decision making.

Mr. Fugate closed by stating that it was important to understand and plan for space weather, and

that we must educate policy-level decision makers on how to effectively respond to these events.

Session 2: A Year Moving Forward – The National Space Weather Program

Moderator: Dr. Richard Behnke, Head, Geospace Section, National Science Foundation (NSF)

Panelists:

Colonel Mark Zettlemoyer for Dr. Fred Lewis, Director of Weather, Headquarters, United States Air Force (USAF)

Ms. Vickie Nadolski, Deputy Assistant Administrator for Weather Services and Deputy Director, National Weather Service (NWS)

Dr. Richard Fisher, Director, Heliophysics Division, NASA Headquarters

Ms. Mary Kicza, Assistant Administrator for Satellite and Information Services (NESDIS), National Oceanic and Atmospheric Administration

- In his initial remarks, Dr. Behnke noted that NSF is funding the Advanced Technology Solar Telescope (ATST). The program represents a collaboration of 22 institutions, reflecting a broad segment of the solar physics community. The design phase of the project is underway currently.
- Colonel Mark Zettlemoyer led off with the Air Force Weather (AFW) philosophy that space weather is a “Team Sport.” In addressing the way ahead, the Air Force is making increased investments in sensor, modeling, and data exploitation capabilities and that AFW is working hard to integrate all available data into operations. He highlighted the Next-Generation Ionosonde (NEXION) system, which will be fielded over the next 5 years and will include at least 30 sites around the world. AFW is also investing in the Improved Solar Optical Observing Network which will be upgraded over the next 5 years. He described how AFW is cooperating with the Global Oscillation Network Group (GONG) to upgrade their H-Alpha solar observing capability and to obtain a solar flare forecast tool. Col Zettlemoyer further highlighted the Space Weather Analysis and Forecast System (SWAFS) and the importance of collaborations with the Community Coordinated Modeling Center (CCMC), Federal research agencies, and their partner in operations—the NOAA/NWS Space Weather Prediction Center (SWPC).
- Ms. Vickie Nadolski, said the NWS strongly supports the SWPC, and planned improvements are a high priority to create a sustainable space weather program. NOAA is transitioning its first physics-based space weather model into operations. Transition will be completed next year with the goal to provide actionable, accurate predictions of geomagnetic storms out to 1-4 days. The new Space Weather Prediction Test bed will enable effective and efficient transition of research models and data streams into operational products and services. NOAA is collaborating with other agencies to help build a more Space Weather resilient society. Ms. Nadolski noted that solar activity is increasing as witnessed in a significant geomagnetic storm in April 2010 and stated that the time for action is now.
- Dr. Richard Fisher, focused on the Solar Dynamics Observatory (SDO). SDO represents a big step forward in technology that will enable scientists to understand solar processes that drive space weather and their impacts. The Radiation Belt Storm Probes—the second mission in NASA’s Living with the Star Program scheduled for launch in May 2012—promise to deliver data on the near-earth space environment to help us understand the magnetospheric response to solar wind and storm variations. He emphasized that NASA’s data, models, and situational awareness software and displays are available on the internet. Dr. Fisher

concluded by highlighting NASA's substantial contributions to the International Living with the Star program.

- Ms. Mary Kicza, said space weather observations are a top priority for NOAA NESDIS. Current NOAA Geostationary Operational Environmental Satellites (GOES) include the Solar X-ray Imager (SXI), as well as several other space weather instruments. The next-generation GOES (GOES-R), scheduled for launch in the 2015 time frame, will carry a suite of three space weather instruments: Extreme Ultraviolet (UV)/X-ray Irradiance Sensor (EXIS); Solar UV Imager; and the Space Environmental In-Situ Suite. The continuity of the operational polar-orbiting satellite program was briefly discussed. Partnering with other government and international agencies as well as industry is a top priority for NOAA. They are currently working with NASA on transitioning research to operations in several areas. The budget for 2011 includes funds for solar wind observations—the DSCOVR satellite, scheduled for launch in 2014. Also NOAA is partnering with Taiwan on a new GPS radio occultation mission. Ms Kicza also stated that there will be future opportunities to partner with industry. In summary, NESDIS is committed to providing sustained space weather observations as evidenced by the President's 2011 budget request.

Session 2: Comments, Questions and Answers

1. (Q) With the increase in polar flights, are we working with the NexGen Air Transportation System folks to identify space weather requirements as they relate to the GPS navigation system?
(A) Ms. Nadolski stated that Tom Bogdan, Director, SWPC, has been working with the FAA to develop requirements for products and services for the 2015-2020 time frame. Later, Ms. Karen Shelton-Mur confirmed that the FAA is working the space weather requirements for NexGen.
2. (Q) There is fear that space weather modeling efforts are coming to an end—"falling off a cliff" so to speak. What is the community doing about it?
(A) Dr. Fisher disagreed, noting that NASA doesn't see the cliff. The CCMC is a viable entity, and basic modeling programs will continue to improve with increased emphasis on model validation. Ms. Kicza also stated the modeling capabilities would be sustained with some modest growth. Dr. Behnke noted the NSF strongly supports interagency space modeling efforts.
3. (Q) Will DSCOVR be launched earlier, possibly in 2012?
(A) The bottom line—not likely. Col Zettlemyer stated we could try to move the launch date up, but the launch vehicle will not be available until 2012, and the money is laid on for a 2013 launch.
4. (C) Diversity in our space weather modeling efforts is extremely important.
(A) Dr. Fisher replied that we are using all assets available, including non-linear dynamics and chaos theory.
5. (Q) Are there any plans to put a coronagraph on DSCOVR?
(A) Ms. Kicza. Not on DSCOVR, but there are plans to provide the capability on a follow-on platform.
6. (Q) How are priorities set?
(A) Dr. Fisher (NASA). NASA has used the National Research Council's National Decadal Survey to develop science goals and priorities for space weather. Ms. Kicza (NESDIS) added that priorities for observations are based on maintaining a legacy and continuity of space weather observations. We must also understand the impact of losing research observations which have been routinely used to support operations.
7. (Q) How can we cut through the red tape for future acquisitions?

- (A) Ms. Kicza. NOAA is looking at ways to streamline the process.
8. (Q) Will the Radiation Belt Storm Probes data be useful for observation?
(A) Dr. Fisher. Not in real time. The data will be available via record and playback and will be very useful for model improvement and model validation.
9. (C) The importance of the CCMC was noted. It was also noted that the observations at L1 to the extremely important to the protection of our critical infrastructure.
10. (C) It was emphasized that there is a need for a more coordinated public education effort in space weather. NASA must zero in on the impacts aspects.
(A) Ms. Nadolski. Since December 2009, there has been a growing demand for information from the SWPC. She proposed to use the NWS forecast office infrastructure to support the effort by training a core set of folks at each of the 122 offices on space weather and its impacts.

Dr. Behnke concluded the session by stating we have made tremendous progress in the National Space Weather Program (NSWP) over the last decade. He also noted the contributions of the other (NSWP) agencies not included as part of the panel; namely, USGS, DOE, and the FAA.

Session 3: The Future of Space Weather Science and Research Transition to Operations

Moderator: Dr. Louis Lanzerotti, Distinguished Research Professor of Physics, Center for Solar-Terrestrial Research, New Jersey Institute of Technology

Panelists:

Dr. Steven Butler, Executive Director, Air Force Materiel Command (AFMC)

Captain Paul Stewart (USN), Commanding Officer, Naval Research Laboratory (NRL), Washington, D.C.

Dr. Arthur Charo, Senior Program Officer, Space Studies Board, National Research Council (NRC)

Dr. Devrie S. Intriligator, Director, Space Plasma Laboratory, Carmel Research Center

- Dr. Lanzerotti opened the session by describing the American Geophysical Union (AGU) Space Weather Journal and asked the audience to submit news and feature articles for consideration. He then highlighted the importance of improving the means to transition research advances to operations, noting the importance of vital feedback from operators to advise researchers on what is needed.
- Dr. Butler highlighted the challenge for space weather to catch up to terrestrial weather, specifically in the areas of improving our knowledge of the processes and our infrastructure to collect the necessary observational data. We need to invest in space-based and ground-based monitoring platforms and apply our understanding of the science to identify the optimal mix to deliver a better product to the warfighter. This in turn will save lives. We have an increasing reliance on space-related technologies, but our advantage could turn to a liability if degraded by space weather. Therefore, we need to be able to predict space weather effects to support operations. The Air Force Research Laboratory (AFRL) has a long history of deploying space weather sensors. They have recently established the Space Weather Forecast Lab to: (1) expose researchers to operational products, (2) expose current techniques to the end user for feedback to the researchers, and (3) couple disparate regions with models. Dr. Butler concluded with the statement that robust research is at the heart of increasing technical understanding which will improve the reliability of our systems and improve our operational capabilities.

- CAPT Stewart highlighted NRL's long and successful heritage, noting that the lab had built and launched 95 satellites over the years—the result of effective collaborations between operators and researchers. He stressed that space weather lags behind terrestrial weather and that a severe space weather event might be needed to focus attention on the increased need for space weather service capabilities. He referenced a typhoon during World War II that destroyed four destroyers which galvanized the Navy's interest in weather. The Navy's reliance on overhead assets makes space weather critically important, and a concerted research investment is warranted. NRL has four new project starts this year in basic and applied research for space weather. In the future, NRL will undertake software research to link models, with the end state being fully coupled models. These models will create a seamless specification and forecast system, backed up with validation and observations. NRL has had 11 launches this past year, studying weather “from crabs to the crab nebula.”
- Dr. Charo serves as the Chief Staff Officer for the NRC Decadal Survey on Solar and Space Physics. He presented an overview of the Decadal Survey process and the Survey's applicability in Research to Operations (R2O). With over 100 contributing researchers, the Decadal Survey is the most influential and extensive of the National Research Council's studies, and it is known for making hard choices and recommendations. Dr. Dan Baker will chair the upcoming survey which will have cross-cutting, interdisciplinary panels. He provided the following link: <http://tinyurl.com/2b4e4sh>. Dr. Charo suggested that R2O in the survey should consist of two parts: modeling and observations. Some progress could be made by looking at structural barriers for effective R2O. Finally, he recommended that the relevant Federal agencies and the scientific community develop and implement plans for sustaining global Earth observations as described in the Earth Science Decadal Survey.
- Dr. Intriligator noted the growing space weather enterprise requires coordination, cooperation, and reliable data. She stressed the importance of partnering when transitioning research to operations. Dr. Intriligator demonstrated some of her cutting-edge research, predicting the environment at the Voyager spacecraft. She discussed R2O efforts and CRC partnering with other small businesses (SET, SEC), USGS, and the Air Force to forecast the Ionospheric Disturbed Index (Dst). Dr. Intriligator showed there were no reliable real-time solar wind data during the Halloween 2003 Storms from the Advanced Composition Explorer spacecraft. Also the Neutron Monitor at Thule has been decommissioned. She recapped the Space Weather Workshop Roundtable and its recommendations, including the community's efforts to get the DSCOVR spacecraft launched as soon as possible.

Session 3: Comments, Questions and Answers

1. Are there a lot of useful classified data sets in military systems? Are you optimistic that appropriate data can be used by the community?
 - (A) CAPT Stewart. Declassification is a challenge. Some data sets are owned by the sponsors and a formal request would be needed to start the process. This is a long process but can be worth the effort.
 - (A) Dr. Butler. We are sponsoring an effort to improve the open sharing of data; however, some will not be able to be shared. As users become more knowledgeable of the benefits of the data, sharing might be more viable. Also, by introducing the scientific community to the engineering community, the resulting dialog might help recognize the value of the various data sets.
2. (Q) Are there other data sets, like the ionosonde data observed by AFWA, available to the scientific community?

- (A) Col Zettlemoyer: Air Force Director of Weather is fielding the NEXION. The data will be net-centric and discoverable through the Joint METOC Brokering Language. It will be shared with the SWPC and possibly available on a time-delayed basis. However, there is limited archive capability, and AFWA is working to make the data available to the research community. It probably will not be available in real-time.
3. (Q) The Army claims to be one of the largest space weather users. How can the scientific community help them? How is the AF helping address this?
 (A) CAPT Stewart: NRL transitions their research through AFWA for all DoD operational services in space weather.
4. (Q) Has there been any outreach to industry to gauge their interest in space weather data, specifically related to infrastructure protection for the power grids and telecommunications from Ground Induced Currents (GIC)?
 (A) Dr. Intriligator stated that there is vital interest and there is an industry report in the works from SWW. There is expertise in industry and internationally. There is a commercial space weather interest group who meets at SWW, and it contains a number of representatives from the power industry. At the workshop, there was a unanimous decision to establish a Space Weather Association which will lobby for further outreach and education.
 (A) Dr. Lanzerotti stated that there was good coupling between equipment operators and the carrier prior to the AT&T breakup, but now it is difficult to get good data because the proprietary nature of the data makes it hard to share.
5. (Q) The K Index produced by NOAA doesn't predict dB/dt for GIC. Will there be an index to predict this?
 (A) Dr. Lanzerotti. There is a paper coming out in the upcoming Space Weather Journal. More real-time data are required.
6. (Q) Besides space weather, there is also space climate. Is there a plan to address solar variability on climate? Given the interdisciplinary nature of space weather, how do you represent this in the Decadal Survey?
 (A) Dr. Charo stated that the survey is appropriate to study climate issues and that someone will be appointed specifically to the steering committee for that purpose. The interdisciplinary nature can be addressed by using cross-topic working groups to get around stovepipes. He is open to suggestions and better ideas.

Session 4: International Activities and Cooperation

Moderator: **Dr. Joseph Davila**, Senior Scientist for Solar Physics, Heliophysics Science Division - NASA Goddard Space Flight Center

Panelists:

Dr. Hans Haubold, United Nations (UN) Office for Outer Space Affairs

Mr. Juha-Pekka Luntama, Space Situational Awareness (SSA) Programme, Space Weather Manager, European Space Agency (ESA), European Space Astronomy Centre, Madrid, Spain

Dr. David Kendall, Director General for Science and Technology, Canadian Space Agency (CSA)

Mr. Richard H. Buenneke, Deputy Director, Space Policy, Bureau of International Security and Nonproliferation, U.S. Department of State (DOS)

- Dr. Hans Haubold discussed UN Basic Space Science Initiative and UN International Program on Space Applications, established 40 years ago. Space weather was included in 2004, and a space weather initiative was adopted in 2009. He highlighted the regional centers for space science and technology education. Dr. Haubold noted that the UN has conducted

workshops on basic space science around the world. As a result of the International Heliophysical Year (IHY) 2007, 100 countries have space environmental instrument arrays. This grass roots, UN effort has both industrialized and developing countries coordinating their efforts and learning from each other in a mutual partnership under a joint understanding of sharing scientific benefits. As a result, trans-border networks have been created and scientific as well as cultural exchange took place. Establishing instrument arrays and exchanging data are a big part of the UN effort.

- Dr. Luntana discussed the Space Weather Element of the ESA SSA programme established in 2008. The Preparatory Programme will run from 2009 to 2011 and the Operational Programme will cover 2011-2019. The main objective of the operational programme will help improve forecasting space weather. He sees competition as part of the winning formula to allow the international community to move forward.
- Dr. David Kendall noted that as a result of the March 13, 1989, severe geomagnetic storm that caused the collapse of the Hydro-Quebec power grid in a matter of seconds, Canada has been the poster child for space weather impacts. Canada has a history of launching space weather satellites, and they are currently working on small satellite technology. Additionally, Canada has an extensive ground-based space weather observing network, and they are working on developing physics-based space weather models. He noted that Canada relies on polar-orbiting satellites for 24/7 communications and forecasting capability. Dr. Kendall stated that they need to work on the following challenges:
 - Making low-probability, high-impact events more compelling to get the public's attention.
 - Addressing whether the world is ready for a high-impact event.
 - Attracting new people with new ideas into the fields to address the challenge.
 - Sharing data and models (and model intercomparisons) is critical.
 - Cooperating on a regional and international basis
- Mr. Bueneke told the forum the U.S. is currently doing a strategy review on the peaceful applications of space. He believes international cooperation is critical to future success. Interdependencies among commercial entities and governments world-wide dictate the need for cooperation and collaboration. Mr. Bueneke stated satellite systems are indispensable, and data must be shared. He reminded the audience that space was becoming congested with orbital objects and therefore space situational awareness is critical. He said the ESA SSA Preparatory Programme, and the long-term sustainability of space activities were two international programs of key interest to the U.S. Mr. Bueneke concluded by saying that space weather has been a model for international cooperation

Session 4: Comments, Questions and Answers

1. NASA commented on the success of the "International Living with the Star" program. Noting the collaborations between NASA, ESA, Japan, and Russia. There are 28 members in all.
2. (C) The European Union (EU) is looking at federalizing European assets and resources as a cost-cutting initiative to support ESA's SSA Programme.
3. USGS commented on the success of international sharing of geomagnetic data over the last two solar cycles.
4. (C) There are unintended consequences of the ITAR policy. (Additional information was found from internet research: Satellite technologies—including those intended for unclassified fundamental research—now fall under the State Department's more

restrictive International Traffic in Arms Regulations (ITAR). Astronomers and other scientists who rely on such satellites are concerned about the impact of these regulations on fundamental research, particularly on international collaborations.)

Session 5: Critical Infrastructure Support

Moderator: Dr. Daniel Baker, Director, Laboratory for Atmospheric and Space Physics (LASP), University of Colorado-Boulder

Panelists:

Rear Admiral Diane Webber, Director, Command Control Systems, North American Aerospace Defense Command (NORAD) and U.S. Northern Command (USNORTHCOM)

Dr. Chris Beck, Congressional Staff Member, House Committee on Homeland Security

Dr. Denise Stephenson-Hawk, Consultant and Former Director, Societal-Environmental Research and Education Laboratory, National Center for Atmospheric Research (NCAR)

- Dr. Baker opened the session by highlighting results from the workshop and report “The Societal and Economic Impacts of Severe Space Weather Events: An NRC Report.” He emphasized the vulnerabilities our systems that make up our national infrastructure to space weather impacts, the complex interdependencies of these systems, and the potential serious implications. He then pointed out the great opportunity our community has been afforded with the initiation of a Decadal Survey on space environmental science. Dr. Baker said he was honored to lead the Decadal Survey and asked for community input and support to help make it a success.
- Rear Admiral Webber stated that USNORTHCOM has the mission for consequence management and constant event monitoring to ensure military assets are ready if called upon to support the nation. NORTHCOM plays a critical role in the National Critical Infrastructure Plan. She emphasized that civil authorities had to request DoD support from the Secretary of Defense or the President and that the DoD would always play supporting role rather than be in charge of the response efforts. Rear Admiral Webber told the forum NORTHCOM has been involved in planning and tabletop exercises on how to handle severe space weather, but the public does not make the connection between impacts and space weather events. Decision makers need information to plan consequence management responses. We need to work together to address the vulnerabilities before they become problems.
- Dr. Beck stated that there needs to be a sense of urgency on the space weather issue. He then posed the question, “What would happen if several hundred transformers go down as result of an extreme space weather event?” It would be a civilization-changing event. Our Nation’s electric grid structure has created a critical vulnerability, and we are not ready for such a high-consequence event. Although the North American Electric Reliability Corporation (NERC) has critical infrastructure protection program which coordinates all of NERC’s efforts to improve physical and cyber security for the bulk power system of North America as it relates to reliability, we need to insure that NERC addresses their vulnerabilities as they relate to space weather as well. The proposed Grid Infrastructure Reliability Act recently passed a vote in the House of Representatives could help in addressing these issues.
- As a tool to try to comprehend the general level of public understanding on space weather, Dr. Stephenson-Hawk asked us to put on the hat of a 10th grade student and try to remember how much science we remember. The public has little knowledge of nature, risks, and

impacts of space weather, and most events go unnoticed. She stated that we cannot live very well in our current world without satellite-enabled systems. Many agencies write their own piece of the space weather puzzle. How do we fit the pieces together, and who's in charge? Now is the time to plan for resilience.

Session 5: Comments, Questions and Answers

1. (Q) Given the past record, we have not been able to anticipate a major, large-scale disaster. Comments? Which audience needs to hear this message? Legislative, policy, social scientists?
(A) Dr. Stephenson-Hawk: Mr. Fugate has begun an exercise to see how prepared we are. FEMA requires all states to have a multi-hazard plan. Each state must address how it will be prepared, how it will recover, and become more resilient.
(A) RDML Webber: We can't predict a severe event; we will likely require a catastrophic event to get action. For fires and hurricanes, we are still caught by surprise. For space weather, the predicting is more problematic and understanding will require more effort. For consequence management, these are so catastrophic that we need a plan. We have identified weaknesses, so now we need to develop the ability to respond.
2. (C) Regarding outreach and education, the challenge is to think through the concept of interdisciplinary action. To get the word out, we may need to work through professional agencies and groups. Logisticians will work independently with NASA to find out what they don't know. Perhaps this expands to universities and others.
(A) Dr. Beck: We don't need a "Stop, Drop, and Roll" campaign for space weather. Professional agencies (like NERC) and associations are the way to go. We don't need and can't rely on one-on-one education. The answer lies in getting the professional and trade organizations actively involved.

Session 6: Summary and Wrap up

Dr. Lanzerotti summarized the forum by stating that it significantly demonstrates how the National Space Weather Program has evolved over the last 17 years. The purpose of the forum was to bring together academia and policy makers in a "policy format." Then through excellent dialog with FEMA, NASA, NSF, DOD, and all the Federal agencies represented in the audience, the forum highlighted past achievements, our challenges, and our plans for moving forward. Participants from the legislative and executive branches expressed their concerns about space weather and the need to understand the differences between extreme and common space weather events. Government officials don't want to unduly sensationalize space weather, but we are concerned about how to handle significant events. Dr Lanzerotti asked, how do we engage industry and academia on how to plan for and anticipate space weather? This leaves us with a lot of interdisciplinary areas to look at, including policy and social science. From what we have heard during the 2010 SWEF, we have made dramatic progress in the space weather enterprise, and we are committed to working together to enhance our Nation's resiliency to the potential impacts of space weather through expanded public outreach and education, improved products and services, and effective planning.