



2019 SPACE WEATHER ENTERPRISE  
FORUM

*PREPARING THE NATION FOR SPACE  
WEATHER*

SPONSORED BY  
THE NATIONAL SPACE WEATHER  
PARTNERSHIP  
AND  
UNITED STATES GEOLOGICAL SURVEY

YATES AUDITORIUM  
DEPARTMENT OF INTERIOR, MAIN BUILDING  
1849 C ST NW, WASHINGTON, DC 20240

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OFFICE OF THE FEDERAL COORDINATOR  
FOR METEOROLOGICAL SERVICES AND SUPPORTING RESEARCH

1325 EAST WEST HIGHWAY, SSMC2, SUITE 7130  
SILVER SPRING, MARYLAND 20910

June 26, 2019

Dear Colleagues,

Welcome to the 2019 Space Weather Enterprise Forum (SWEF)! We are pleased to present a wide-ranging and informative slate of speakers to address this year's theme: Preparing the Nation for Space Weather. Our distinguished speakers are national leaders and stakeholders from across government, industry, and academia, representing the array of activities from setting policy to guiding research to providing operational support for both civilian and national defense applications.

I want to express my sincere appreciation to Senator Cory Gardner, Director James Reilly of the United States Geological Survey (USGS), and the Director of the National Weather Service, Dr. Louis Uccellini, for their opening remarks as well as all the Session Moderators and Speakers for their keen insights. I would also like to thank the USGS for hosting the 2019 SWEF in the spectacular new Yates auditorium in the Department of Interior Main Building; the members of the NSWP and the SWEF Organizing Committee for helping to plan the forum.

Finally, I thank you, the SWEF participants for the gift of your time and attention. Your contributions to the exchange of ideas, sharing of information, and raising awareness of space weather and its effects will help to build an informed and resilient society for the years ahead.

Enjoy the forum!

Sincerely,

Mr. Michael F. Bonadonna

Federal Coordinator for Meteorology

and

Executive Secretary, Space Weather Operations, Research and Mitigation Interagency Working Group

# Introduction

The 12th annual Space Weather Enterprise Forum (SWEF) will continue its tradition of excellence building a strong partnership among space weather experts from both research and operations, space weather users from the public and private sectors, academia, international representatives, and policy makers. Our Objectives for the Forum are to:

1. Discuss vulnerabilities of our technological infrastructure to space weather impacts
2. Support actions being taken to prepare for and respond to space weather impacts
3. Highlight partnership opportunities between the government, commercial, and academic stakeholders
4. Emphasize the importance of new policy guidance pending space weather related legislation

Since the last SWEF in July 2018, the National Space Weather Partnership (NSWP) has continued to expand and strengthen relationships among the federal agencies, commercial, and academic institutes engaged in space weather operational services and supporting research efforts. The National Science and Technology Council has completed a reorganization aligning the Space Weather Operations, Research, and Mitigation (SWORM) Interagency Working Group under a new Subcommittee for Space Weather, Security, and Hazards (SWSH) and published an update to the National Space Weather Strategy and Action Plan (NSW-SAP) sharpening our focus on the critical challenges facing our nation.

The 2019 SWEF has been organized specifically to address and support each of the three Objectives of the NSW-SAP:

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.

We will also explore current and planned space weather capabilities to support the needs of an increasingly space-reliant and space-faring nation.

## **National Space Weather Partnership**

Following the establishment of the Space Weather Operations, Research, and Mitigation (SWORM) Subcommittee under the National Science and Technology Council (NSTC) within the Executive Office of the President Office of Science and Technology (EOP-OSTP), the Office of the Federal Coordinator for Meteorological Services and Supporting Research (OFCM) deactivated the National Space Weather Program Council and established the National Space Weather Partnership (NSWP). The partnership replaces the internal US Government program with a public forum to support the “all-of-community” approach espoused in the National Space Weather Strategy Action Plan (NSW-SAP). The SWORM activity has been reorganized as an Interagency Working Group (SWORM IWG) designed to provide oversight and direction to the integrated process of setting national priorities, focusing agency efforts, and leveraging resources. It ensures coordination and collaboration across all Federal agencies involved in space weather activities. The NSWP supports the SWORM IWG by maintaining external coordination and community outreach in compliance with Federal Advisory Committee Act (FACA) regulations.

## The Venue:

Yates Auditorium

Department of Interior, Main Building

1849 C St NW, Washington, DC 20240



US Department of Interior main building, exterior



US Department of Interior main building, interior

# 2019 Space Weather Enterprise Forum Agenda

“Preparing the Nation for Space Weather”

June 26, 2019

Yates Auditorium

Department of Interior, Main Bldg

1849 C St NW, Washington, DC 20240

**7:30 am Registration**

**8:30 am Session 1: Welcome and Opening Addresses**

- **Dr. William Leith**, Senior Science Advisor for Earthquake and Geologic Hazards U.S. Geological Survey (USGS)
- **The Honorable Cory Gardner**, United States Senate
- **Dr. Jim Reilly**, Director, United States Geological Survey (USGS)
- **Dr. Louis Uccellini**, National Oceanic and Atmospheric Administration (NOAA) Assistant Administrator for Weather Services and Director, National Weather Service

**9:30 am Session 2: Preparing for Space Weather Impacts**

Moderator: **Dr. Antti Pulkenn**, Deputy Director, Heliophysics Science Division, National Aeronautics and Space Administration (NASA), Goddard Space Flight Center

- **Dr. Jeffrey Love**, Research Geophysicist, Advisor for Geomagnetic Research, US Geological Survey (USGS)
- **Mr. John Moura**, Director - Reliability Assessment at the North American Electric Reliability Corporation (NERC)
- **Dr. Emanuel Bernabeu**, Director, Applied Innovation & Analytics, PJM Interconnection

**10:35 am Break**

**10:50 am Session 3: Advancing Space Weather Science and Services**

Moderator: **Dr. Devrie Intriligator**, Director, Space Plasma Laboratory, Carmel Research Center, Inc. and American Commercial Space Weather Association Executive Committee

- **Mr. Clinton Wallace**, Director, NOAA Space Weather Prediction Center
- **Dr. James Spann**, Chief Scientist, Heliophysics Division Chief Scientist, Headquarters National Aeronautics and Space Administration (NASA).
- **Dr. Conrad C. Lautenbacher Jr.**, Chief Executive Officer, GeoOptics Incorporated and American Commercial Space Weather Association.
- **Dr. Daniel Baker**, Director Laboratory for Atmospheric and Space Physics, University of Colorado, Boulder.

**12:10 pm Lunch**

**1:30 pm Session 4: Space Weather for a Space Faring Nation**

Moderator: **Mr. Steve Clarke**, Deputy Associate Administrator for Exploration, Science Mission Directorate, NASA HQ

- **Dr. Eddie Semones**, NASA Space Radiation Analysis Group, Johnson Space Flight Center
- **Mr. Ralph Stoffler**, Director of Weather, Deputy Chief of Staff for Operations, Headquarters, U.S. Air Force.
- **Ms. Karen Shelton Mur**, Office of Commercial Space Transportation, Federal Aviation Administration
- **Mr. Richard Ullman**, Deputy Director, Office of Projects, Planning, and Analysis (OPPA) National Environmental Satellite Data and Information Service (NESDIS)

**3:15 pm**            **Break**

**3:30 pm**            **Session 5: Response and Recovery following Space Weather Events**

Moderator: **Jackie Keshian**, Policy Advisor, Executive Office of President (EOP), Office of Science and Technology Policy (OSTP)

- **Ms. Kenyetta Blunt**, Chief, Recovery Planning Branch, Federal Emergency Management Agency (FEMA)
- **Mr. John Ostrich**, Infrastructure Systems Analyst at U.S. Department of Energy
- **Mr. Frank Koza**, Electric Subsector Coordinator, Electricity Infrastructure Security (EIS) Council

**4:35 pm**            **Session 6: Summary and Wrap up**

**Mr. Michael Bonadonna**, Executive Secretary, Space Weather Operations Research and Mitigation (SWORM) Interagency Working Group and Director, Office of the Federal Coordinator for Meteorology (OFCM)

**Dr. William Leith**, Senior Science Advisor for Earthquake and Geologic Hazards U.S. Geological Survey (USGS)

**4:45 pm**            **End**

## Session 1: Opening and Keynote Talks



Dawn on the Power Grid

Space weather comprises a set of naturally occurring phenomena that have the potential to adversely affect critical functions, assets, and operations in space and on Earth. Extreme space weather events can degrade or damage critical infrastructures, which may result in direct or cascading failures across key services such as electric power, communications, water supply, healthcare, and transportation. Preparing for space weather events will help protect infrastructure and activities vital to national security and the economy of the United States.

The 2019 Space Weather Enterprise Forum has been organized around the 2029 National Space Weather Strategy and Action Plan (NSW-SAP) and includes a special interest topic emphasizing space weather impacts on space systems and human space flight.

The venue was selected to highlight the key role that the Department of Interior, United States Geological Survey plays in support of the national space weather analysis and forecasting capability and the potential devastating effects of Geomagnetic storm ground induced currents on the national power distribution grid.

Dr. William "Bill" Leith

Senior Science Advisor for Earthquake and Geologic Hazards,

United States Geological Survey



Dr. William (Bill) Leith is the Senior Science Advisor for Earthquake and Geologic Hazards at the U. S. Geological Survey (USGS). In this position, he oversees the Earthquake Hazards, Geomagnetism and Global Seismographic Network Programs, and represents the Department of the Interior within the National Space Weather Program. Dr. Leith previously served USGS as Chief of the USGS Special Geologic Studies Group from 1990-2001, as Senior Technical Advisor to the Assistant Secretary of State for Verification and Compliance, from 2001-2003, as the Coordinator of the Advanced National Seismic System from 2003-2012, and as USGS Acting Associate Director in 2010-2011. Bill has over 100 publications in the areas of seismology, geology, engineering geology, tectonics, and the applications of these subjects to earthquake safety, response and engineering, as

well as to nuclear weapons testing and test monitoring, treaty verification and compliance assessments, and other national security interests.

## U. S. Senator Cory Gardner

Senator Cory Gardner is a fifth-generation Coloradan who was born and raised in Yuma, a small town on the Eastern Plains of Colorado where his family has owned a farm implement dealership for over a century. He lives in the same house his great-grandparents lived in. Cory graduated summa cum laude from Colorado State University and received his law degree from the University of Colorado Boulder. After working at his family implement business and the National Corn Growers Association, Cory took a position as a Legislative Assistant for Senator Wayne Allard (R-CO) and quickly advanced to his Legislative Director.



He began serving in the Colorado House of Representatives in 2005 where he spent time as the Minority Whip and became known for his expertise in natural resource and agriculture policy. Cory was elected to the U.S. House of Representatives in 2010. As a member of the House Energy and Commerce Committee, Cory championed a true all-of-the-above energy strategy that promoted traditional resources as well as renewable energy. In addition, Cory is a national leader on energy efficiency initiatives and founded a bipartisan energy efficiency caucus in the House.

In the Senate, Cory continues to pursue common sense energy policy as a member of the Senate Energy & Natural Resource Committee and Chairman of the Energy Subcommittee. In addition, Cory serves on the Foreign Relations Committee, and the Commerce, Science, and Transportation Committee. He also serves as Chairman of the Subcommittee on East Asia, the Pacific, and International Cybersecurity Policy.

As Chairman of the Foreign Relations Subcommittee on East Asia, the Pacific, and International Cybersecurity Policy, Cory led the effort to impose broad new sanctions against North Korea, as the regime continues to be a leading abuser of human rights and its reckless advancement of nuclear weapons threatens our national security.

In 2017, Cory was ranked as the 8th most bipartisan Senator by The Lugar Center and was awarded the Legislative Action Award by the Bipartisan Policy Center (BPC) in 2018 for his work to build consensus, elevate the tenor of the debate, practice civility, and advance legislation on pressing issues.

Cory is focused on expanding the economy, creating jobs, and making life better for all Coloradans.

He lives in Yuma with his wife Jaime and their three children: Alyson, Thatcher, and Caitlyn.

Committee Assignments

[Energy and Natural Resources](#)

[Commerce, Science and Transportation](#)

[Foreign Relations](#)

Senator Gardner is the chairman of the ['Subcommittee On East Asia, The Pacific, And International Cybersecurity Policy'](#)

# Jim Reilly

Director

U.S. Geological Survey



As Director of the USGS, Jim Reilly is responsible for leading the Nation's largest water, Earth, and biological science, and civilian mapping agency.

## **Career History and Highlights**

Prior to joining the USGS, Dr. Reilly served U.S. and allied militaries as a subject matter expert on space operations, and as a technical advisor supporting the National Security Space Institute of the U.S. Air Force. He served with the U.S. Navy as a Reserve Engineering Duty Officer.

He's held management positions in academia, as well as at TAEUS Corporation, and PhotoStencil Corporation, in Colorado Springs,

Colorado.

As an astronaut at NASA, he had a distinguished 13-year career where he flew 3 spaceflight missions and conducted 5 spacewalks totaling more than 856 hours in space.

Prior to NASA, he served as chief geologist at Enserch Exploration, Inc., working on projects around the world. He has been active in geological research in Antarctica and on the continental slope of the Gulf of Mexico.

## **Education**

Dr. Reilly received a bachelor's, master's and doctorate degrees in geosciences from the University of Texas at Dallas.

## Dr. Louis W. Uccellini

Assistant Administrator for Weather Services,  
National Oceanic and Atmospheric Administration (NOAA), and Director, National  
Weather Service

Dr. Louis W. Uccellini is the National Oceanic and Atmospheric Administration's Assistant Administrator for Weather Services, and Director of the National Weather Service. In this role, he is responsible for the day-to-day civilian weather operations for the United States, its territories, adjacent waters, and ocean areas.

Prior to this position, he served as the Director of the National Centers for Environmental Prediction (NCEP) for 14 years. He was responsible for directing and planning the science, technology, and operations related to NCEP's nine centers.

Dr. Uccellini was the Director of the National Weather Service's Office of Meteorology from 1994 to 1999, Chief of the National Weather Service's Meteorological Operations Division from 1989 to 1994, and section head for the Mesoscale Analysis and Modeling Section at the Goddard Space Flight Center's Laboratory for Atmospheres from 1978 to 1989.

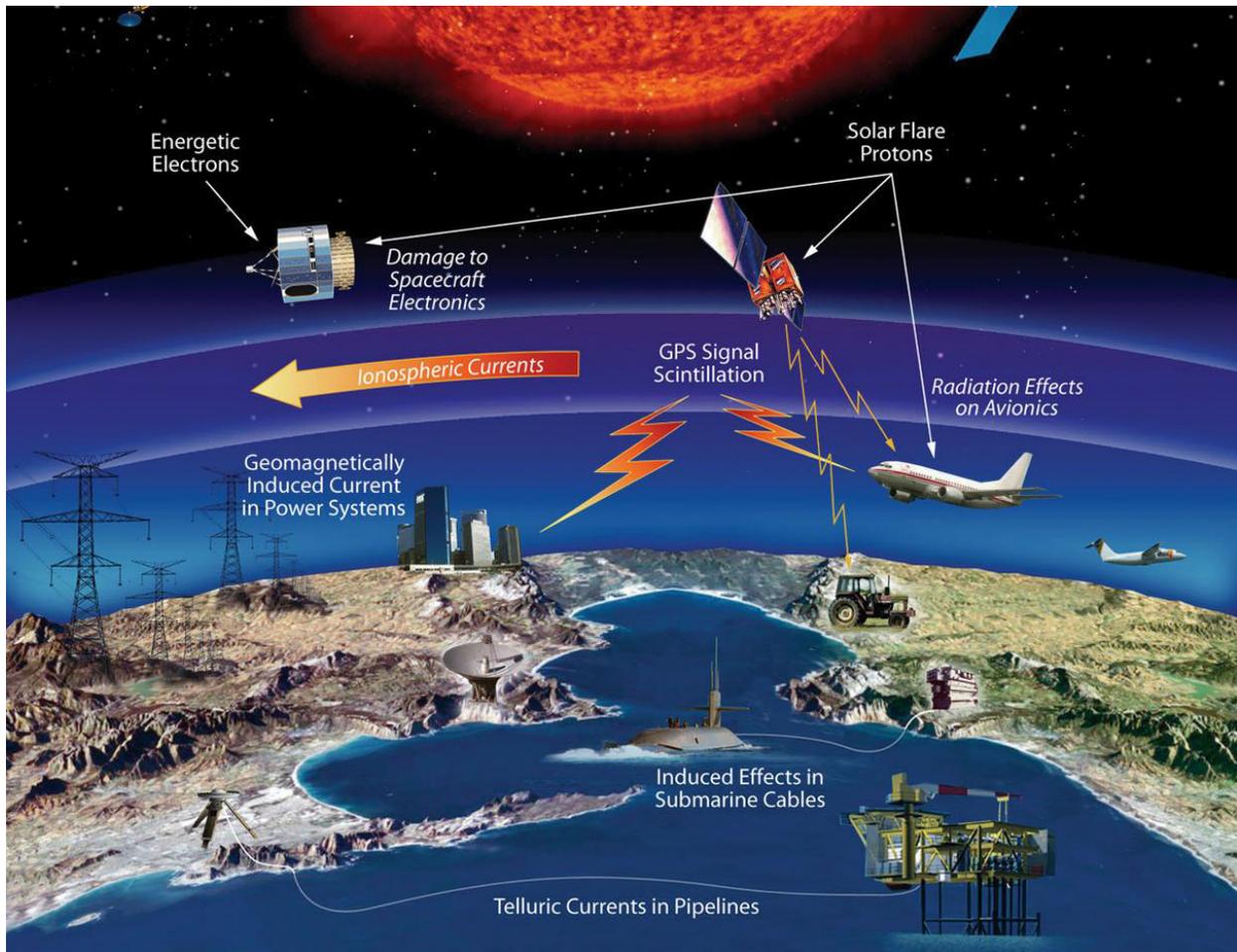
Dr. Uccellini received his Ph.D. (1977), Master (1972) and Bachelor of Science (1971) degrees in meteorology from the University of Wisconsin-Madison. He has published more than 70+ peer-reviewed articles and chapters in books on subjects including analysis of severe weather outbreaks, snowstorms, gravity waves, jet streaks, cyclones, and the use of satellite data in analysis and modeling applications and more recently the basis for the Joint Center for Satellite Data Assimilation, the WMO based Grand Challenge for Seamless Prediction and the Restructuring of the NWS to Build a Weather Ready Nation.

Dr. Uccellini is the Permanent US Representative at the World Meteorological Organization, and has served on many national and international research and field experiment programs. He has received many awards in recognition of his research and operational achievements including the Maryland Academy of Sciences Distinguished Young Scientist Award (1981), the NASA Medal for Exceptional Scientific Achievement (1985), the AMS's prestigious Clarence Leroy Meisinger Award (1985), the Cleveland Abbe Award (2016), and the National Weather Association's Research Achievement Awards for Significant Contributions to Operational Meteorology (1996). He was elected as President of the AMS in 2012- 2013 and served as Co-Chief Editor of Weather and Forecasting from 1988-1992. In 2001 he received the U.S. Presidential Meritorious Executive Rank Award and in 2006 he received the U.S. Presidential Distinguished Rank Award.



## Session 2: Preparing for Space Weather Impacts

Space weather poses a risk to civilian critical infrastructure, defense and intelligence systems, and military operations. Strengthening critical infrastructure security and resilience to space weather events requires an understanding of and a reduction in critical infrastructure vulnerabilities to the effects of space weather. Space weather effects on ground systems, such as radars, or space-, air-, and ground-based communication links, pose a risk to national and homeland security. Developing and refining strategies to protect against and mitigate the potential disruptive effects of space weather, such as hardening critical assets, can minimize space weather risks and enhance resilience.



## Dr. Antti Pulkkinen



Dr. Pulkkinen is currently Deputy Director of the Heliophysics Science Division at NASA Goddard Space Flight Center. Dr. Pulkkinen received his PhD in theoretical physics from the University of Helsinki, Finland

in 2003. Subsequently he joined the nonlinear dynamics group at NASA Goddard Space Flight Center to carry out his postdoctoral research 2004-2006. Dr. Pulkkinen's PhD and postdoctoral research involved studies on both ground effects of space weather and complex nonlinear dynamics of the magnetosphere-ionosphere system. 2011-2013 Dr. Pulkkinen worked as an Associate Director of Institute for Astrophysics and Computational Sciences and as an Associate Professor at The Catholic University of America (CUA). At CUA Dr. Pulkkinen launched a new Space Sciences and Space Weather program crafted to educate the next generation space weather scientists and operators.

Dr. Pulkkinen has been leading numerous space weather-related projects where scientists have worked in close collaboration with the end-users. In many of these projects his work has involved empirical and first-principles modeling of space weather, analysis of data from NASA heliophysics missions and investigations of solar effects on manmade systems in space and on the ground. Dr. Pulkkinen was awarded NASA Exceptional Achievement Award 2015 and The International Kristian Birkeland Medal 2016 for his efforts to address space weather effects on power grids.

## Magnetic-storm geoelectric hazard maps and the induction of voltages on power-grids

Jeffrey J. Love, Paul A. Bedrosian, Greg M. Lucas, Anna Kelbert, E. Joshua Rigler

*USGS Geomagnetism Program and USGS Geology, Geophysics, and Geochemistry Science Center*

A summary is presented of recent research pursued by the U.S. Geological Survey (USGS) Geomagnetism Program undertaken in support of priorities established by National Space Weather Action Plan of the National Science and Technology Council's Space Weather Operations, Response, and Mitigation (SWORM) Working Group. Results are presented of analyses made of geoelectric fields that are induced in the Earth's electrically conducting interior during intense magnetic storms and their representation as maps and as voltages induced on electric-power grid networks. Estimates of geoelectric fields are obtained by convolution of geomagnetic time series (such as those provided by USGS observatories) with Earth-surface impedance tensors (such as those obtained by the EarthScope project of the National Science Foundation). Statistical analysis of long geoelectric amplitude time series gives estimates of extreme-values, such as those realized during rare but intense magnetic storms. Time-dependent maps of geoelectric vectors are constructed for individual magnetic storms, and voltages on power-grid lines are estimated by integrating the geoelectric vectors along the length of the transmission lines. Results inform studies of resilience of power-grid networks to geomagnetic disturbance as mandated by the Federal Energy Regulatory Commission (FERC), which is now being undertaken by utility companies within the North American Electric Reliability Corporation (NERC). Results also highlight the practical importance of both long-

term geomagnetic monitoring and continental-scale magnetotelluric surveys.

Jeffrey J. Love received an A.B. in physics and applied mathematics in 1985 from the University of California, Berkeley and a Ph.D. in geophysics from Harvard University in 1993. He has worked in Europe and in the United States on a wide variety of subjects related to the Earth's magnetic field. Since 2001, Dr. Love has worked as a research geophysicist at the U.S. Geological Survey. He concentrates on using geomagnetic monitoring data and magnetotelluric survey data to evaluate geoelectric hazards that are a concern to the electric-power grid industry. He serves on a number of committees, including on the Executive Council of INTERMAGNET and on the Space Weather Operations Response and Mitigation (SWORM) Working Group of the United States National Science and Technology Council.

Mr. John N. Moura

Director, Reliability Assessment and System Analysis, NERC

The North American Electric Reliability Corporation (NERC) is a not-for-profit international regulatory authority whose mission is to assure the reliability and security of the bulk power system (BPS) in North America. NERC develops and enforces Reliability Standards; annually assesses seasonal and long-term reliability; monitors the BPS through system awareness; and educates, trains, and certifies industry personnel.

While the impacts of space weather are complex and depend on numerous factors, space weather has demonstrated the potential to effect the reliable operation of the Bulk-Power System. Severe-impact geomagnetic disturbance (GMD) events present risks and vulnerabilities that are not fully addressed in conventional bulk power system planning, design, and operating processes. Geomagnetic storms emanating from the sun can produce an

impulsive disturbance to earth's geomagnetic field over wide geographic regions. This field disturbance causes induced quasi-DC ground currents (geomagnetically induced currents or GIC), which can, depending on the ground impedances, flow through the high voltage system. During a GMD event, geomagnetically-induced current (GIC) flow in transformers may cause half-cycle saturation, which can increase absorption of Reactive Power, generate harmonic currents, and cause transformer hot spot heating. Increased transformer Reactive Power absorption and harmonic currents associated with GMD events can also cause protection system Misoperation and loss of Reactive Power sources, the combination of which can lead to voltage collapse. Though the most likely result is voltage collapse, particularly large GIC flows can result in transformer damage and may result in the failure of some transformers. The industry is well-equipped to face a small number of transformer failures; however, due to the concerns about an extreme GMD event causing a larger than expected number of failures, it is important to carefully quantify the nature of the reliability risk.

NERC and the electric power industry have developed mandatory Reliability Standards that require certain operational actions by system operators, planning requirements, and vulnerability modeling. The Reliability Standards identify the benchmark GMD event that controls the severity GMD event utilities entities must assess. Utilities are required to conduct initial and on-going assessments of the potential impact of benchmark

GMD events on their respective systems. The assessments are based on a severe 1-in-100 year GMD event. Further refinements continue as NERC continues to conduct research in concert with EPRI to identify, among other things, sensitivities around current methodologies and harmonic impacts.

#### **BIOGRAPHY**

John Moura is the Director of Reliability Assessment and System Analysis for the North

American Electric Reliability Corporation (NERC), where he joined in 2008. John leads the electric reliability organization's efforts to independently assess and report on the overall reliability, adequacy, and associated risks of the interconnected North American bulk power system. John leads the development of NERC's annual long-term and seasonal reliability assessments, as well as NERC's efforts in evaluating reliability impacts of potential environmental regulations, high-levels of variable generation, geomagnetic disturbances, and the increasing dependence on natural gas. He is the co-author of numerous NERC special reports and technical publications.

John coordinates the efforts of NERC's Planning Committee and several other stakeholder groups, which brings together the power industry's leading experts on resource and transmission planning. John leads a team of engineers focused on evaluating wide-area reliability risks, identifying solutions, and measuring mitigation effectiveness. In addition, John is actively engaged in multiple technical groups and committees across North America focused on the power system risk and vulnerability analyses, loss of load studies, probabilistic resource adequacy modeling, and interconnection-wide power system modeling. In his capacity as a subject-matter expert on BPS reliability, John provides testimony in numerous state and federal hearings across the country. John earned his bachelor degree from Rutgers University.

## Dr. Emanuel E. Bernabeu

Director of the Applied Innovation & Analytics department of PJM Interconnection

### **Abstract**

Geomagnetically induced currents (GIC) are the manifestation of space weather driven by solar activity. Disturbances on Earth's geomagnetic field induce a geoelectric field at the Earth's surface, which drives GIC. These quasi-DC

currents flow through transmission lines and enter/exit the power grid through grounded transformer neutrals.

The flow of GIC can drive power transformers into half-cycle saturation, increasing the reactive power consumed by the transformer, injecting even and odd harmonics into the system, and potentially generating hotspots in the windings and/or structural components. Combined, these effects may result in equipment loss-of-life, equipment damage, and/or a system wide disturbance; the most famous geomagnetic disturbance is the Hydro-Quebec blackout in March 1989.

Dr. Bernabeu will provide an overview of PJM's strategy to mitigate the impact of GMDs. The strategy is built upon three pillars: situational awareness, operational procedures, and equipment hardening. The discussion will be framed in the context of a 1-in-100 year GMD event (NERC standards TPL-007-3 and EOP-010).

Dr. Bernabeu leads the Applied Innovation & Analytics department at PJM; a cross silo team that focuses on Research-&Development, Special Studies, Analytics, and Market Surveillance. His team embraces innovation and fosters collaboration with PJM's members, national laboratories, industry, and universities to operationalize emerging technologies; for example: synchrophasors, enhanced situational awareness (DIMA), cascading outages analysis, etc. The team also conducts Special Studies that require advanced modeling techniques: fuel security, EMP, GMD, physical attacks, etc.

Prior to joining PJM, Dr. Bernabeu spent 5 years with Dominion Virginia Power in Richmond, VA, holding a consultant engineering position.

Dr. Bernabeu has a B.S. in Electronics from the Universidad Catolica de Cordoba, a M.S. in Power Systems, a M.S. in Applied Economics, and a Ph.D. in Power Systems from Virginia Tech.

[PJM Interconnection](#), founded in 1927, ensures the reliability of the high-voltage electric power system serving 65 million people in all or parts

of Delaware, Illinois, Indiana, Kentucky, Maryland, Michigan, New Jersey, North Carolina, Ohio, Pennsylvania, Tennessee, Virginia, West Virginia and the District of Columbia. PJM coordinates and directs the operation of the region's transmission grid, which includes over 82,000 miles of transmission lines; administers a competitive

wholesale electricity market; and plans regional transmission expansion improvements to maintain grid reliability and relieve congestion. PJM's regional grid and market operations produce annual savings of \$2.8 billion to \$3.1 billion. For the latest news about PJM, visit PJM Inside Lines at [insidelines.pjm.com](https://www.insidelines.pjm.com)

## Session 3: Advancing Space Weather Science and Services

Timely and accurate space weather characterization and forecasts are critical to inform the planning, execution, and decision-making of operations for a diverse set of stakeholders including critical infrastructure owners and operators, the military, and private sector satellite owners and operators. Improved understanding, observations, forecasts, and models for space weather events can lead to better quality and more timely space weather products and services as well as contribute to supporting safe, stable, and sustainable space activities.



Parker Solar probe



NOAA Space Weather Prediction Center

Moderator

Dr. Devrie S. Intriligator

Director, Space Plasma Laboratory,  
Carmel Research Center, Inc.

ACSWA Executive Committee



Dr. Devrie S. Intriligator is a leading space weather prediction expert. She has published more than 140 papers in refereed publications, 100 as principal author, many at the forefront of space plasma physics and space weather. Her expertise includes space weather measurements, simulations, modeling, and predictions for operational excellence. Her team at Carmel Research Center provides services to spacecraft, aviation, astronauts, space-tourism, ground-based electric power, and pipelines. An Executive Committee member of the American Commercial Space Weather Association (ACSWA), Intriligator chairs the Annual NOAA SWPC-Commercial Sector Summits.

Dr. Intriligator has served as chair of the National Academy of Sciences Committee on Solar-Terrestrial Research. She co-chaired (with Dr. Herbert Friedman) the NAS-NRC study "Solar-Terrestrial Research for the 1980s" and chaired the NAS-NRC study "National Solar-Terrestrial Research Program." These studies led to current satellite missions and programs including the National Space Weather Program.

Dr. Intriligator has presented numerous briefings to key U.S. government officials, including the President's Science Advisor.

Dr. Intriligator's plasma investigations have revealed fundamental physical and space weather processes. Experiments on which she was a co-investigator, aboard Pioneer 10 to Jupiter and Pioneer 11 to Jupiter and Saturn, were the first to measure phenomena including space weather at these planets. Now both spacecraft are among the farthest manmade objects from Earth. Dr. Intriligator also was a key investigator on experiments aboard Pioneer Venus Orbiter and on heliocentric spacecraft Pioneer 6, 7, 8, and 9. She participated in all phases of mission and experiment development including initial conception, instrument design, spaceflight operations, data analyses, and publications. Dr. Intriligator is an inventor of cosmic ray and space plasma detectors. She was the first U.S. scientist invited to place an experiment on a Soviet spacecraft.

Dr. Intriligator's professional experience includes: physics faculty member, University of Southern California; Visiting Associate and Research Fellow, California Institute of Technology; and Resident Research Associate, NASA Ames Research Center. She has served as a member of numerous boards and study groups at the National Academy of Sciences, National Research Council. She was the first woman to chair the NAS-NRC Committee on Solar-Terrestrial Research.

Dr. Intriligator holds S.B. and S.M. degrees from the Massachusetts Institute of Technology, and a Ph.D. from UCLA.

Mr. Clinton E. Wallace

NOAA National Weather Service

(NWS)

Space Weather Prediction Center

(SPC), Director

Our Nation is embarking on important efforts to modernize infrastructure across all national critical sectors, based largely on advanced technology vulnerable to space weather. The National Oceanic and Atmospheric Administration (NOAA) Space Weather Prediction Center (SWPC) is the Nation's official source for forecasts and warnings of space weather to the civil and commercial community. SWPC is working closely with government agencies and with industry to better understand the needs for space weather products and services. Making our high-tech community ready, responsive, and resilient to extreme severe space weather storms is an NWS priority in building a weather-ready Nation. SWPC's rapidly growing customer base requires that new products and services be developed to support a very diverse user community with interests in national security, emergency response, electric power grids, aviation, communications, global positioning system (GPS) applications, spacecraft operations, and space exploration. Better products require new observations and improved modeling. This presentation will focus on SWPC's evolving customer base and will highlight the significant progress on improving our observing and prediction capability to enhance the Nation's readiness, responsiveness, and resilience against space-weather events.

Mr. Wallace joined SWPC in March 2019. SWPC is the Nation's official civilian source of space weather alerts and warnings, and one of the National Weather Service's nine National Centers of Environmental Prediction. The SWPC continually monitors and forecasts Earth's space environment to provide accurate, reliable, and useful solar-terrestrial information,

and leads programs to improve services. The domain for space weather extends well beyond the Sun and Earth into the planetary system, where the effects of Space Weather can jeopardize aviation, aerospace, satellite, communication, electric power grid operations, in addition to other important commercial sectors.

Prior to his service at SWPC, Wallace served as Deputy Director of NOAA's Aviation Weather Center (AWC) in Kansas City, Missouri since 2010, where he fostered a world-class culture, expanded hiring, and oversaw major advances in decision support products and services to aviation customers.

Previously, Wallace was Chief of AWC's Aviation Support Branch from late 2003 to 2010, directing aviation research-to-operations and operations-to-research while championing the application of new innovations, collaborative science and applied research efforts. He also served as a Research & Development Meteorologist at AWC from 1999 to 2003, as an Agricultural Weather Analyst at the Climate Prediction Center from 1998 to 1999, and as a Research Associate with the Cooperative Institute for Mesoscale Meteorological Studies at the National Severe Storms Laboratory in Norman, OK from 1995 to 1998.

# NASA vision for implementation of the Heliophysics Space Weather Science and Applications Program

James Spann

NASA Heliophysics Space Weather Lead

NASA is a mission driven agency whose science mission is focused on discovering the secrets of the universe, looking for life elsewhere, and safeguarding and improving life on Earth. Heliophysics plays a key role in every aspect of the NASA science mission, including understanding the drivers of and enabling the prediction of space weather. Heliophysics has an established research program that motivates and funds solar and space physics, which is the essence and foundation of space weather research. Recently, the Heliophysics Division established a Space Weather Science and Applications Program, SWxSA. The objective of this competed program is to enable the transition of the knowledge and understanding of space weather to operation environments, by partnering with sister agencies, the commercial sector, and academia. SWxSA leverages relevant NASA capabilities to reach this objective. This talk provides an overview of SWxSA and new initiatives relevant to space weather in the NASA Heliophysics Division, and future directions.

## BIOGRAPHY

Dr. James F. (Jim) Spann, Jr., is the Heliophysics Division Space Weather Lead at NASA Headquarters. During his 32-year NASA career, he developed and flew in space several auroral UV remote sensing instruments, managed the Marshall Space Flight Center's (MSFC) science research organization, which includes the disciplines of Astrophysics, Planetary Science, Heliophysics and Earth Science, and served as the MSFC Chief Scientist. A laboratory physicist

by training, he earned his BS in mathematics and physics from Ouachita Baptist University (cum laude 1979) and his PhD in physics from the University of Arkansas (1985). He is the author or co-author of more than 70 peer reviewed journal articles primarily in space physics. He is the Principle Investigator of an international 6U CubeSat mission with the Brazilian space agency called SPORT that will investigate the conditions in Earth's ionosphere, just above its upper atmosphere, that lead to disruptions in communication and GPS signals. He is actively engaged in defining science that exploration at NASA enables, the establishment of the NASA Space Weather Science and Exploration program, and coordinating space weather activities with national and international partners.

## Space Weather Enterprise Development: Sharpening Roles and Improving Collaboration

Conrad C. Lautenbacher Jr.

The presentation will chart the development path of the Space Weather Enterprise including a description and evolution of the various components and current status. Future dialogue must be sharpened if we are to create more effective and efficient collaboration among enterprise components. Enhanced space weather event preparedness should be our ultimate goal.

## BIOGRAPHY

Retired U.S. Navy Vice Admiral Conrad C. Lautenbacher, Jr. is the CEO of GeoOptics Inc., and serves on several boards including AccuWeather, Georgia Aquarium, and Southeastern Coastal Ocean Observing Regional Association (SECOORA). Formerly he was Vice President of Scientific Support for CSC Corporation.

As Undersecretary of Commerce for Oceans and Atmosphere and Administrator of the National Oceanic and Atmospheric Administration

(NOAA) (2001-2008), Lautenbacher spearheaded the first international Earth Observation Summit in Washington in July 2003 and the subsequent activity to establish the Group on Earth Observations (GEO) and a sustained Global Earth Observation System of Systems (GEOSS).

Before joining NOAA, he served as President and CEO of the Consortium for Oceanographic Research and Education (CORE) now known as the Consortium for Ocean Leadership (COL).

As a Navy Flag Officer (Vice Admiral) he served as Commander, U.S. Third Fleet, Director of Force Structure, Resources, and Assessments (J-8) on the Joint Staff, Commander of U.S. Naval Forces, Riyadh during Operations Desert Shield and Desert Storm. and Deputy Chief of Naval Operations (N-8) responsible for developing the Navy Future (five) Years Program and annual budget.

He is a graduate of the U.S. Naval Academy (B.S.'64) and holds M.S. and Ph.D. degrees from Harvard University in applied mathematics.

## Space Weather – Technology, Research, and Education Center (SWx-TREC) at CU-Boulder

Dr. Daniel Baker

Director and Distinguished Professor, Laboratory for Atmospheric and Space Physics, University of Colorado Boulder

SWx-TREC is a Center at the University of Colorado – Boulder initiated under a grant intended to create a focus for the many units at CU working on space weather topics. TREC is in the College of Engineering and Applied Science and the Laboratory for Atmospheric and Space Physics (LASP). It is able to work across the usual academic boundaries to better develop and integrate space weather models, missions, and data that have a direct benefit to the

operational forecasting offices. TREC is the focal point for creating undergraduate, graduate, and professional courses in space weather. TREC is currently making strategic investments in research-to-operations (R2O) projects such as an improved full-physics model of Low-Earth-Orbit satellite and debris drag, as well as operations-to-research (O2R) projects including improvements to solar magnetic field measurements and models that form the basis of operational solar wind forecasting models. In addition, TREC hosts a “space weather data portal” and a forecast center “test bed”, enabling close interaction between operational forecasters and researchers from around the nation and the world. In short, TREC is a new academic research and technology center dedicated to helping bridge the gap between space weather research and operations, and to educating the space science workforce, from undergraduates to industry professionals. TREC works with national and international operational forecast centers, industry, other academic groups, and NSF and NASA centers such as the NASA/NSF CCMC, to develop and transition new models and tools that improve space weather forecasting and nowcasting. TREC also is focusing significant effort on its educational mission in alignment with CU’s mission as a leading space science university.

### BIOGRAPHY

Daniel N. Baker is Director of the Laboratory for Atmospheric and Space Physics, University of Colorado – Boulder Campus. He is Distinguished Professor of Planetary and Space Physics at CU and is Professor of Astrophysical and Planetary Sciences and Professor of Physics there. Dr. Baker received his Ph.D. working under Prof. James A. Van Allen and subsequently worked with Prof. Edward C. Stone as a Research Fellow in the Department of Physics at the California Institute of Technology. He was Group Leader for Space Plasma Physics at Los Alamos National Laboratory (1980-87) and was Division Chief at NASA’s Goddard Space Flight Center (1987-1994). Dr. Baker presently holds the Moog-

Broad Reach Endowed Chair of Space Sciences at CU. He was a member of the 2006 Decadal Review of the U.S. National Space Weather Program and chaired the National Research Council's 2013-2022 Decadal Survey in Solar and Space Physics. He has edited nine books and published over 800 papers in the refereed literature. He is an elected member of the U.S. National Academy of Engineering. Dr. Baker was the 2010 winner of the AIAA James Van Allen Space Environments Medal. In 2015 Dr. Baker was chosen as the Vikram A. Sarabhai Professor of the Indian Physical Research Laboratory. He

also received in 2015 the Shen Kuo Medal of the International Association of Geomagnetism and Aeronomy (IAGA) for his interdisciplinary leadership in space and Earth sciences. He was chosen in 2016 as winner of the Colorado Governor's Award for High-Impact Research related to his Space Weather research. Dr. Baker was the recipient of the 2018 William Bowie Medal of the American Geophysical Union for outstanding geoscience research. He also is the recipient of the 2019 Hannes Alfvén Medal of the European Geosciences Union.

## Session 4: Space Weather for a Spacefaring Nation

Space weather can damage or disrupt space-based assets, jeopardize or impair crewed and uncrewed space activities, and adversely affect the ability to track objects in space. Understanding vulnerabilities to and protecting against the effects of space weather should inform satellite and spacecraft owners' and operators' design and engineering plans, mitigation strategies, and operational decision-making in the space environment.

The National Security Strategy also identifies the need for the United States to maintain leadership and freedom of action in space, including advancing space as a priority domain, promoting space commerce, and maintaining the lead in exploration. Enhanced resilience to space weather events will contribute to these elements of National Security Strategy.

Additionally, with the emergence of space tourism and increased human presence in space, we must prepare to provide space weather services for a spacefaring nation.



SpaceX Dragon Commercial Resupply to the International Space Station over Aurora

## Steven W. Clarke



National  
Aeronautics and  
Space  
Administration

*Space Weather for  
a Space Faring  
Nation*

*Moderator: Steve  
Clarke, Deputy Associate Administrator for  
Exploration, NASA Headquarters*

In December 2017, the President of the United States signed Space Policy Directive-1, directing NASA to lead an innovative and sustainable program of exploration with commercial and international partners to enable human expansion across the solar system and to bring back to Earth new knowledge and opportunities. On March 26, 2019, Vice President Pence directed NASA to return humans to the surface of the Moon by 2024. Mr. Clarke will provide a brief update to NASA's progress in meeting these directives.

Steve Clarke is the Deputy Associate Administrator for Exploration in NASA's Science Mission Directorate. He serves as the agency's interface between the NASA mission directorates, the scientific community, and other external stakeholders in developing and implementing Space Policy Directive-1 using an integrated approach to achieve science and human exploration objectives for the Moon and Mars.

Clarke returned to NASA after serving as a senior policy analyst with the Office of Science and Technology Policy in the Executive Office of the President, where he was responsible for leading a number of important initiatives, including space weather. He led the Space Weather Operations, Research and Mitigation

(SWORM) Subcommittee as the Office of Science and Technology Policy (OSTP) co-chair.

Mr. Clarke was previously the Director of the Heliophysics Division, responsible for leading the formulation and implementation of a national research program, through scientific flight investigations and research grants, to understand the Sun, its interactions with the Earth and the solar system, and how the observed phenomena impacts life and society.

As the Director of the Joint Agency Satellite Division, he led reimbursable spacecraft and instrument development activities performed by NASA for partner agencies, including the Deep Space Climate Observatory, Joint Polar Satellite System and the Geostationary Operational Environmental Satellite (GOES)-R series.

Mr. Clarke supported the Deputy Associate Administrator of the Exploration Systems Development Division at NASA Headquarters where he was responsible for developing the architecture for human exploration beyond Earth orbit.

Mr. Clarke has received numerous awards during his career including the Presidential Rank Award and NASA's Exceptional Achievement Medal for outstanding leadership.

He has a BS degree in engineering and a MS degree in engineering management from the University of Central Florida.

## Mr. Eddie Semones

NASA Johnson Space Center, Space  
Radiation Analysis Group

As human spaceflight goals extend from Low-Earth Orbit (LEO) missions like the International Space Station to the moon, Mars and beyond, the Space Radiation Analysis Group (SRAG) at Johnson Space Center will need to update their approach for mitigation of crew radiation exposure due to large Solar Particle Events (SPEs). Complications for exo-LEO missions include the lack of protection from the Earth's

geomagnetic field as experienced by the ISS as well as limited communication capability between the crew and the ground. Although vehicle shielding is an important aspect of radiation exposure protection, there is also a continued requirement to monitor and predict the space weather environment in case of a need for the crew to take protective action (i.e., seek shelter); to this end, SRAG maintains a console position in Mission Control with 24/7 mission support capability. SRAG's concept of operations for exo-LEO missions will transition from nowcasting to an emphasis of improving forecasting capabilities, providing the Flight Control Team with more information when responding to a space weather event. Recommendations toward achieving this capability will be discussed.

#### **BIOGRAPHY**

Mr. Semones is the lead of the NASA Space Radiation Analysis Group (SRAG) at Johnson Space Center and the NASA Radiation Health Officer. He is also principle Scientist of the NASA Advanced Exploration Systems' Radworks project. Responsibilities include scientific leadership for all radiation-detection hardware and space weather development projects for the future Artemis missions.

Mr. Ralph O. Stoffler

United States Air Force, Director of Weather

The U.S. Air Force provides operational space weather support to all elements of the DoD. The Air Force's Space Weather Operations Center and U.S. Strategic Command's Combined Space Operations Center carry out this responsibility through 24/7 space operations centers that incorporate space weather observations from various DoD, U.S. Government, and community sources to supply tailored products to warfighters and other users around the globe. These products are a synergistic combination of ground and space-based sensor data and space and terrestrial

environmental models, enabling informed decision-making by operational commanders. The Air Force's Director of Weather will discuss the Air Force's space weather mission and mandate to provide space weather collection, analysis, forecasting, and application capabilities to the DoD and Intelligence Community. He will provide insight into the DoD perspective on space weather observing and forecasting and its importance to the global mission set through a series of vignettes that highlight DoD mission impacts caused by space weather. The Director of Weather will conclude with a discussion of current and future plans for modernizing Air Force Space Weather Enterprise capabilities, including observation networks, modeling and forecasting applications, force development, and research and development investments.

#### **BIOGRAPHY**

Mr. Ralph O. Stoffler, a member of the Senior Executive Service, is Director of Weather, Directorate of Weather, Deputy Chief of Staff, Operations, Headquarters, U.S. Air Force, Washington, D.C. Mr. Stoffler is responsible for developing and implementing weather doctrine, policies, plans, programs, and standards. He plans and programs for Air Force Weather resources and monitors the execution of the weather program totaling \$350 million per year. Mr. Stoffler manages the 4,412-person weather career field, and he interfaces with Air Force Major Commands and the U.S. Army regarding full exploitation of Air Force weather resources and technology. Additionally, he directs interagency activities with the Department of Commerce, the National Aeronautics and Space Administration, and the Federal Aviation Administration.

Mr. Stoffler retired from the Air Force as a Colonel after 30 years of service. While on active duty, he commanded a weather squadron and served as the Deputy Director of Weather among numerous other operational, staff, and training positions. Prior to assuming his current position, Mr. Stoffler was the

Technical Director and Acting Director of Weather for the Directorate of Weather at Headquarters, U.S. Air Force. Mr. Stoffler holds a Bachelor of Science degree in Meteorology from the University of Oklahoma and a Master of Science degree in Systems Management from the University of Southern California.

## Ms. Karen Shelton-Mur

### FAA, Office of Commercial Space Transportation (AST)

The FAA, through the Office of Commercial Space Transportation (AST), issues licenses and permits for the launch and reentry of commercial space vehicles consistent with public health and safety, safety of property, and the national security and foreign policy interests of the United States. AST's mission also includes the responsibility to encourage, facilitate, and promote U.S. commercial space transportation. The commercial space transportation industry in the United States is dynamic, growing, and evolving. In Fiscal Year 2018, there were 32 launches and 3 reentries of commercial space vehicles for a total of 35 licensed activities--a record. Other records in 2019 were set by Virgin Galactic's, Beth Moses who became the first woman to fly to space on a commercial reusable launch vehicle. To date, seven crew members from Virgin Galactic have flown to suborbital altitudes on Space Ship Two. Blue Origin, another commercial reusable launch vehicle operator conducting suborbital test flights has flown its New Shepard vertical takeoff vertical landing vehicle successfully 5 times from its west Texas launch site. Both Virgin Galactic and Blue Origin will soon be transporting paying passengers to suborbital altitudes! In late 2019, or early 2020, the U.S. will be transporting astronauts to the International Space Station (ISS), the first time since the U.S. Shuttle was retired in 2011; and, the first time a commercial company will be transporting NASA astronauts in its own commercially built launch vehicle. A space renaissance is indeed occurring within the

commercial space sector and soon more and more human activity will take place in the near Earth environment, exposing more humans to the effects of enhanced radiation.

### **BIOGRAPHY**

Karen Shelton-Mur joined AST in May 2003. She began her career in the Regulations and Analysis division where she lead rulemaking efforts involving launch regulations for natural and triggered lightning flight commit criteria. She was the Experimental Permit Team Lead and Lead Safety Inspector for Armadillo Aerospace, the first suborbital reusable launch vehicle operator to fly under an FAA Experimental Permit. From 2009 to 2010 she was the Program Manager for AST Safety Approvals and the successfully led the evaluation and issuance of Safety Approvals for two companies in 2010. From 2011-2015, she worked in the Space Transportation Development division where she was involved with integrating commercial launch and reentry activity into the National Airspace System (NAS). Presently, she resides in the Office of the Chief

Engineer and oversees AST's research and development activities for NAS Integration, Space Traffic Management, and Spaceports. In addition, she leads and manages AST's space and terrestrial weather portfolio to enhance operational safety of current and future launch vehicle licensees or permittees.

Karen is also a Lt Col in the USAF Reserve serving as an Emergency Preparedness Liaison Officer for FEMA's Region III. She previously served as the 121st Weather Flight Commander in the District of Columbia Air National Guard, and as a Staff Weather Officer for the Texas Air National Guard. She was commissioned in 1999 and holds a B.S. and M.S. in Meteorology from Texas A&M University.

# NOAA's Current and Future Space Weather Observational Architecture

Richard Ullman

Deputy Director of OPPA

NESDIS Office of Projects, Planning,  
and Analysis

NOAA observational responsibilities in support of space weather forecasting are in the context of significant, numerous, complementary international and domestic efforts. Each measurement plays a unique role at different phases of the forecasting or event characterization process. This paper overviews the current suite of observations that NOAA maintains and utilizes on various platforms and the status of the NOAA/NESDIS plan forward efforts for the Space Weather Follow-On (SWFO) program and other projects to provide needed continuity.

## **BIOGRAPHY**

Richard Ullman is the Deputy Director of the NESDIS Office of Projects, Planning and Analysis. In this role, he assists the OPPA Director in overseeing the the development, acquisition,

integration, installation, and acceptance of major system elements (spacecraft, instruments, launch services, and ground services) for NOAA's operational environmental satellite systems. In support of these activities, he also assists the OPPA Director in overseeing requirements definition studies, conceptual and detailed engineering design and overall systems planning.

Mr. Ullman joined NOAA in 2013 as Deputy Chief of OPPA's Program Management and Execution Division and he has been a key team member in NOAA's oversight of the COSMIC-2, DSCOVR, MetOP-C and Jason-3 missions. Before joining OPPA, Richard spent twenty five years at NASA Goddard Space Flight Center working in Earth Science Data Systems engineering and development, including supporting both our JPSS and GOES-R programs. Richard was the JPSS data products engineering lead for the development and deployment of the NPP GRAVITE calibration/validation support system and he served as data products systems engineer and data products deputy division chief prior to the JPSS program transition. Before that he served as a lead systems engineer for the GOES-R ground project during the systems requirements definition phase.

Mr. Ullman has a Master of Science in computer engineering from Johns Hopkins University and a Bachelor of Science in physics from Dickinson College.

## Session 5: Response and Recovery following Space Weather Events

The ability to rapidly respond to and recover from extreme space weather events requires coordinated efforts and established plans and procedures. Conducting exercises to test and validate these plans and strategies can allow relevant stakeholders to practice and refine them. An improved understanding of critical system and asset vulnerabilities to the effects of space weather, and a robust forecasting capability that can enable more timely and accurate services and products are important to inform Federal, State, local governments', private sector and others' efforts, capabilities, and investments in managing space weather events.



PONCE, Puerto Rico – A large supply of transformers are stored at the laydown yard in Ponce, Puerto Rico, May 22. The transformers, a critical component of the grid restoration mission, were in high demand early on in the mission to 'turn the lights on' in Puerto Rico. USACE logisticians continue supporting Hurricane Maria recovery efforts by maintaining supply chains at the port. FEMA mission assigned USACE the central responsibility for purchase and distribution of all Bill of Materiel (BOM) supplies needed for the grid restoration mission. To date, USACE has allocated more than \$323 million

Contributor: [AB Forces News Collection](#) / Alamy Stock Photo

## Jackie Keshian

### Office of Science and Technology Policy



Jackie Keshian began working at the Office of Science and Technology Policy (OSTP) in February 2019. She currently serves as a Policy Advisor handling space issues and legislative affairs and is the Co-Chair of the Space

Weather Operations, Research, and Mitigation Interagency Working Group, under the National Science and Technology Council.

Prior to her role at OSTP, Jackie served on the staff of the Senate Committee on Commerce, Science, and Transportation for former Chairman John Thune. During her four years with the Committee, Jackie's portfolio included aviation operations and safety policy, with a focus on unmanned aircraft systems, as well as civil space policy. In this role, Jackie had the opportunity to help draft numerous pieces of legislation, including the FAA Reauthorization Act of 2018 and the National Aeronautics and Space Administration Transition Authorization Act of 2017. Jackie also previously spent time serving in the Massachusetts State House as the Chief Legislative Aide to a member of the Massachusetts House of Representatives.

Jackie is a native of Massachusetts and holds a bachelor's degree in political science from Boston College, where she also minored in economics and international studies.

## Kenyetta Blunt

### Federal Emergency Management Agency

#### Acting Deputy Director, Planning & Exercise Division

The Federal Emergency Management Agency coordinates the federal government's role in preparing for, preventing, mitigating the effects of, responding to, and recovering from all domestic disasters, whether natural or man-made, including acts of terror.

#### **BIOGRAPHY**

Kenyetta Blunt currently serves as the Acting Deputy Division Director of FEMA's Planning and Exercise Division where she helps oversee the activities of the directorate. In addition, she is also the Chief of the National Planning Branch in the Planning Division.

In that role she is responsible for overseeing the daily operations of Division in addition to the development, review and revision of comprehensive Federal Interagency Response and Recovery Plans. These plans provide the federal government's strategic and operational actions for responding to and recovering from incidents to include, but not limited to chemical, oil, nuclear, long-term power outages, biological, space weather as well as regional and national level incidents.

Before moving to the Response Directorate, Ms. Blunt served as the Chief of the Recovery Planning, Exercise and Doctrine Branch within the Recovery Directorate. While there her responsibilities included the development of national policy doctrine to include the development of the National Disaster Recovery Framework and the Recovery Federal Interagency Operation Plan. She was also developed several exercises that specifically addressed short and longer term recovery issues.

Ms. Blunt spent several years working in FEMA's Individual Assistance Policy Branch where she developed policies, procedures, guidance for all parts of FEMA's Individual and Households Program. She started her career with FEMA reviewing and processing disaster assistance claims from disaster survivors.

Prior to working with FEMA, Ms. Blunt worked as a contractor with the Department of Energy where she would conduct technical reviews and analysis of the departments' historical data to determine if the materials could be declassified in accordance with Executive Order 12958.

## John T. Ostrich, Jr.

Risk and Hazard Analysis Program Manager

Infrastructure Security and Energy Restoration  
Cybersecurity, Energy Security, and Emergency  
Response

U.S. Department of Energy

The Department of Energy's (DOE) Office of Cybersecurity, Energy Security, and Emergency Response (CESER) prepares for all threats and hazards, but is currently focusing on cybersecurity and addressing the EMP threat and GMD hazard. An extreme space weather event, such as a 100-year storm, can cause adverse consequences including possible damage to critical equipment. Mitigation solutions exist and protection measures are possible. DOE has response plans in place to help expedite recovery from an extreme space weather event, should adverse consequences occur. DOE's CE-SMART program plans to enhance EMP and GMD simulation, modeling, analysis, research and testing capabilities over the next few years.

### **BIOGRAPHY**

John Ostrich is program manager of Risks and Hazards Analysis at the U.S. Department of Energy. In this role he identifies, initiates and manages a variety of projects addressing threats and hazards and enhancing resilience of critical energy functions, assets, systems, and

networks. Over the past several years he has focused his attention on addressing the risks of EMP and GMD to the electric grid. Mr. Ostrich represents the DOE at many interagency policy groups and task forces related to preparedness for natural disasters and adversarial threats. Mr. Ostrich has provided subject matter expertise and program management support to DOE since 1992 on all aspects of energy systems, networks, and markets. For eight years he wrote or edited and published a daily report on energy infrastructure status called the Energy Assurance Daily. Mr. Ostrich has also been on DOE's Emergency Response Team since 2004 and has participated in most of DOE's major response activations over the past 15 years.

Prior to supporting DOE missions, Mr. Ostrich provided defense and intelligence support for the U.S. Government or many years related to Chinese and Soviet defense strategy and planning.

## Mr. Frank J. Koza

Electric Subsector Coordinator

Electricity Infrastructure Security (EIS)  
Council

EIS Council fosters national and international collaboration on resilience, planning and response to black sky events which can have devastating impacts to the electric power system and other critical infrastructures. To that end, EIS Council has periodic meetings to discuss these issues, has created a set of handbooks that address specific events and their associated risks, and facilitates black sky exercises. One category of black sky events is extreme space weather as can be expected from coronal mass ejections (CMEs) from the Sun. Mr. Koza will review the potential impacts to the power system from CMEs and what the industry is doing to respond to the threat. EIS Council continues to work with government and the industry to increase resilience to these types of events.

## **BIOGRAPHY**

Mr. Koza retired in 2017 after a 45-year career in the power industry and am now doing part-time consulting work, including work with the EIS Council. Prior to retirement, he worked at PJM for 16 years, in system operations and system planning. Mr. Koza was Chair of the NERC Geomagnetic Disturbance Task Force and Standard Drafting Team and former Chair of the NERC Operating Reliability Subcommittee. Prior

to PJM, he worked for 29 years at Exelon/PECO Energy in a variety of assignments including construction of fossil and nuclear generation facilities, construction and maintenance of transmission, system planning, and system operations.

BSME, University of Pennsylvania, 1972

Master of Eng., Widener University, 1979

Registered Professional Engineer, PA

## Session 6: Summary and Wrap-Up

Mr. Michael Bonadonna

Director and Federal Coordinator for Meteorology

Office of the Federal Coordinator for Meteorological Services and Supporting Research



Mr. Michael Bonadonna is the Federal Coordinator for Meteorological Services and Supporting Research. In this role, he directs a team that fosters cooperative efforts in environmental services across fifteen government departments and agencies active in the Federal meteorological enterprise.

Prior to becoming the Federal Coordinator, Mr. Bonadonna served as the Secretariat for Federal Meteorological Coordination at the Office of the Federal Coordinator for Meteorology (OFCM) in Silver Spring, MD. He held a number of roles including the Executive Secretary roles for the Space Weather Research and Mitigation Subcommittee of the National Science Council, the National Space Weather Program Council, and Committee for Operational Environmental Satellites. Prior to his tenure at OFCM, Mr. Bonadonna was assigned as the Senior Policy Advisor for Space and Satellite Programs at the National Weather Service Headquarters and Senior User Representative at the National Polar-orbiting Operational Environmental Satellite Program Executive Office. He is a 24-year U.S. Air Force veteran having served as a Meteorologist, Political Military Affairs, and Security Assistance Officer in numerous assignments providing operational weather support to the US Air Force, US Army, and allied forces during peace and war in the United States, Europe, South Korea, and Qatar.

Mr. Bonadonna earned a Master of Science degree in Meteorology from the Pennsylvania State University, a degree in National Security from the Joint Force Staff College and Air University, and a Program Management Certificate from the George Washington University.

# Acknowledgements

We want to thank the National Space Weather Partnership (NSWP) members especially, Dr. William Leith for hosting the event. The 2019 Space Weather Enterprise Forum would not have been possible without the sponsorship and support of the United States Geological Survey. We are very grateful for your interest and space of the National Space Weather Community!

Our commercial, academic, and public partners continue to expand. We are especially gratefully for increasing participation of the American Commercial Space Weather Association (ACSWA).

We sincerely appreciate the support of the SWEF Organizing Committee and the staff of the Office of the Federal Coordinator for Meteorology for all the months of planning and dedication to conducting the SWEF each year.

Finally, we especially thank all of our speakers, moderators, panelists, and participants for their informative insights and information.

## **Host**

William Leith (USGS)

## **Keynote Speakers**

U. S. Senator Cory Gardner

James Reilly (USGS)

Louis Uccellini (NOAA)

## **Session Moderators**

Steven Clarke (NASA)

Devrie Intriligator (ACSWA-CRC)

Jackie Keshian (OSTP)

Antti Pulkkinen (NASA)

## **Program Coordinator**

Michael Bonadonna (OFCM)

## **Registration, Website, Program Support**

Erin McNamara (OFCM)

## **Rapporteurs**

Jud Stailey (OFCM)

## **SWEF Organizing Committee**

Christina Bork (OFCM)

Jennifer Gannon (ACSWA-CPI)

Maj Janelle Jenniges (USAF)

Jeffry Love (USGS)

Erin McNamara (OFCM)

Jennifer Meehan (NOAA)

William Murtagh (NOAA)

Karen Shelton-Mur (FAA)

James Spann (NASA)

Josh Wolny (SWF)

## **Financial and Logistics Support**

Ken Barnett (OFCM)

Christina Bork (OFCM)

David Chorney (OFCM)

Sim James (OFCM)

Ivett Shields (OFCM)



The American Commercial Space Weather Association (ACSWA) is comprised of 19 companies with the common goal of developing, delivering, and sustaining key space weather products and services to mitigate threats to societal infrastructure. Space weather is a natural hazard that disrupts and damages modern systems, including electric power grids, airlines, global navigation, and satellite operations. ACSWA plays an essential role in the academic-governmental-commercial triad that forms the space weather enterprise. ACSWA companies provide the insight, innovation, and cost-benefit to our Nation's preparedness and responsiveness to space weather threats. ACSWA helps protect America's economic strength and national security.

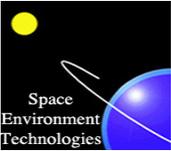
ACSWA products and services include both data and technology needed for space weather resilience. Member companies develop value-added products and services informed by their unique relationship with industry partners and in-depth understanding of specific user needs. Contributions include risk and threat assessment, scientific discovery, data product development, numerical modeling and simulations, data assimilation, machine learning, enterprise IT, sensor response modeling, small satellite deployment, and development and operation of ground-based and space-based sensors. ACSWA companies also propose and deliver novel solutions such as data buys from commercially-owned observational platforms. These comprehensive contributions support space weather preparedness across the public and private sectors.

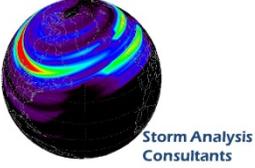
ACSWA is a collective voice for the commercial space weather sector and an advocate for the enterprise. Since its inception in 2010 beginning with five companies, ACSWA has quadrupled in size. ACSWA serves as a catalyst for collaboration between various organizations and the commercial space weather industry. ACSWA works with government agencies, academia, and industry stakeholders to strengthen the space weather enterprise and to promote space weather, space weather partnerships, and public/commercial initiatives.

[ACSWA – Building a strong space weather enterprise](#)

American Commercial Space Weather Association (ACSWA.us)

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|---|--|
|    | <p>Atmospheric and Environmental Research (AER): AER offers unique weather, space weather, and climate R&amp;D, consulting, and services as well as related remote sensing and forecast modeling expertise. AER has extensive expertise in developing algorithms and performing sensor engineering design trade-off studies for meteorological parameters measured by operational and research space-based sensors and systems.</p>        |
|    | <p>Atmospheric &amp; Space Technology Research Associates (ASTRA): ASTRA spans science, technology development and applications, including: full-physics modeling of the ionosphere and thermosphere; data assimilation for electron density, TEC, neutral density and satellite drag; ground-based instrument development from HF systems, to GPS receivers; small satellite missions and space weather sensors for small satellites.</p> |
|    | <p>Carmel Research Center (CRC): For more than 40 years, CRC has been at the forefront of space physics and space weather innovation. CRC's physicists, computer scientists, and technologists work together to push the cutting edge of science and technology, with core expertise in simulations, modeling, predictions, flight hardware, spacecraft operations, data reduction, and data analyses for operational excellence.</p>      |
|  | <p>Computational Physics Inc. (CPI): Founded in 1984, CPI's foundation is in science, from the ocean to space. CPI provides scientific and technical support to satellite remote sensing programs, builds earth and planetary radiation models, develops high precision spectral sensors, and builds and maintains magnetometers and real-time hazard models for power utility planning and operations.</p>                                |
|  | <p>GeoOptics: GeoOptics is an environmental data company that delivers a wealth of information about our changing planet. GNSS-Radio Occultation is the foundational dataset for key applications that includes operational daily weather forecasting, space weather ionospheric measurements, and long-term environmental monitoring and research.</p>  |
|  | <p>NextGen Federal Systems: NextGen is an innovative information technology and professional services provider specializing in advanced software solutions as well as comprehensive mission and business support services. The NextGen approach is to design, develop, implement, and manage information technology (IT) solutions that measurably improve our customer's organizational performance.</p>                                  |

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|    | <p>PlanetIQ, LLC: PlanetIQ is deploying a privately funded constellation of small satellites in Low Earth Orbit (LEO) to collect environmental &amp; atmospheric observations from space. The data include measurements of Total Electron Count (TEC), Ionosphere Scintillations, the F-Region, and a number of in-situ properties such as electric and magnetic field vectors, and local charged particle properties.</p>  |
|    | <p>Predictive Science, Inc.: Predictive Science Inc. (PSI) is an employee-owned company that delivers state-of-the-art scientific solutions to customers. PSI strives to provide exceptional and creative solutions that can be tested against real-world observations and experiments, within a working environment that rewards and encourages professional excellence and ethically-based entrepreneurial activities.</p>  |
|    | <p>Propagation Research Associates, Inc.: Propagation Research Associates, Inc. (PRA) is a small company with a highly motivated and innovative staff consisting of physicists, mathematicians, and electrical engineers. Founded to develop remote sensing technology to characterize the refraction and turbulence in the troposphere, PRA evolved this capability into remote sensing in the ionosphere to provide a total electron count (TEC) for understanding radar frequency propagation phenomena in the ionosphere.</p> |
|   | <p>Q-up Now: Q-up is dedicated to serving the corporate radio network, amateur radio operator, and the emergency responder communities. Organized in 2011, it provides global, accurate, real-time and forecast high frequency (HF) radio propagation information that accounts for the known effects of dynamic space weather upon the ionosphere.</p>   |
|  | <p>Space Environment Corporation (SEC): SEC was established in 1989 to develop software and hardware solutions to space science and space weather needs. SEC's core expertise is in the development and deployment of upper atmosphere models and data analysis tools for space weather forecasts and specifications.</p>   |
|  | <p>Space Environment Technologies (SET): SET has provided modeling and simulation of solar irradiances and indices, Dst, thermospheric densities, and the aviation radiation environment. The company has developed algorithms and software tools for historical, real-time, and forecast solar irradiances and surface-to-LEO radiation.</p>   |
|  | <p>Space Hazards Applications (SHA): Space Hazards Applications investigates the physics that controls space weather and captures that understanding in user friendly applications designed to mitigate impacts to our technological infrastructure. SHA's primary focus is on providing tools for understanding the impact on satellite systems from the intense high-energy radiation environment that surrounds Earth.</p>   |

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|  | <p>Space Services Holdings, Inc.: Space Services Holdings, Inc. is leading a team of established and entrepreneurial companies to investigate new commercial opportunities in space weather and remote telecommunications applications.</p>   |
|  | <p>Storm Analysis Consultants (SAC): SAC is the world's leading consulting firm in the Analysis of Geomagnetic Storms, Space Weather, and Electro Magnetic Pulse (EMP) and how they impact critical infrastructures, electric power grids, communication systems. SAC provides a range of services that include: assessing and modeling the space weather threat environment and assessing Impact on critical infrastructures and systems, geomagnetic storm nowcasting and forecasting technology tailored to the electrical power Industry.</p> |
|  | <p>SciencePrime, LLC: SciencePrime, LLC, offers project management and proposal preparation consulting services concentrating on space weather science and technology. With extensive experience in federal agency efforts to coordinate space weather research activities, SciencePrime advises on a broad range of strategies to help promote and advance space weather knowledge</p>   |