Space Weather Enterprise Forum

Solar Maximum 2013: How Space Weather Will Affect You!

Program

Sponsored by the National Space Weather Program Council
National Press Club
Washington, DC

June 5, 2012

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June 5, 2012

Dear Colleagues,

Welcome to the 2012 Space Weather Enterprise Forum! The members of the National Space Weather Program (NSWP) Council are pleased to present a wide-ranging and informative slate of speakers to address this year's theme: *Solar Maximum 2013 – How Space Weather Will Affect You!* They are national and international leaders and stakeholders from across government, industry, and academia, and represent the array of activities from setting policy to guiding research to providing operational support for both civilian and national defense applications.

Our objectives in organizing this year's forum are to share information across the enterprise and raise awareness for new users, decision makers, and policymakers; to identify effective approaches to raise awareness and build resilience in the broader society, particularly in the area of critical infrastructure support; to improve communications within and external to the enterprise; and to begin collecting information to support the development of new NSWP Science and Implementation Plans.

In the past year, the NSWP established the Unified National Space Weather Capability (UNSWC) which will provide synergy among the national space weather science service providers to yield improved services to the Nation. Today, we are rolling out the new National Space Weather Portal website: www.spaceweather.gov/portal as the principal tool to access UNSWC services. Additionally, we completed a study for the White House Office of Science and Technology Policy that moved critical observing system capabilities closer to reality than ever before. These are just a few of the milestones on our recent journey, and they point to an even brighter future. The discussions today will help us review progress, look forward, and focus our efforts on preparing for the next decade and the risks and challenges ahead.

I extend my appreciation to the members of the OFCM-sponsored NSWP Council and all of their representatives who helped plan the forum. It is with the Council's direction that the Office of the Federal Coordinator for Meteorology organized and is hosting the forum today.

Thank you for attending and contributing to the exchange of ideas, sharing of information, raising awareness of space weather and its effects, and building an informed and resilient society in the decade ahead. Please join in the discussions and enjoy the forum!

Sincerely,

Samuel P. Williamson
Federal Coordinator for Meteorology
and Chairman, National Space Weather Program Council

Space Weather Enterprise Forum 2012

Solar Maximum 2013 – How Space Weather Will Affect You!
National Press Club
Washington DC
June 5, 2012

Motivation

The next peak of solar activity expected in 2013 has already begun and impacts from powerful space weather events are causing impacts to the technical infrastructure that underpins our economy and society. The Nation faces many uncertainties from increasing reliance on space weather-affected technologies for communications, navigation, security, electrical power generation and distribution, and other activities. We also face increasing exposure to space weather-driven human health risks as trans-polar flights and space activities, including space tourism and space commercialization, increase.

The Forum

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. This year, we will continue this outreach but will sharpen the focus on critical infrastructure protection and human health and safety, 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 the potentially devastating impacts of space weather events on our health, economy, and national security.

Forum Objectives

- Share information across the enterprise and raise awareness for new users, decision makers, and policymakers; areas of exchange include the following:
    - New research results
    - New transitions of research into operations
    - New products and services
    - Unified space weather operational capabilities
    - International activities and cooperation
    - Commercial space weather users and providers
    - Integration of social science into space weather services
- Identify effective approaches to build resilience across society, particularly in critical infrastructure protection and support.
- Identify effective approaches to raise awareness in the broader society.
- Improve communications within and external to the enterprise.
- Collect information to support the development of new National Space Weather Program Science and Implementation Plans.

Sponsor

The National Space Weather Program Council is part of the U.S. Federal meteorological coordinating infrastructure under the Office of the Federal Coordinator for Meteorological Services and Supporting Research (OFCM). The Council brings together the Federal agencies involved in providing space weather products and services, space weather research, users of space weather information, and other offices that set policy or funding for the Federal portion of the space weather enterprise. The purpose is to facilitate coordination, collaboration, and leveraging of activities, results, and capabilities across the Federal agencies. The participating agencies and their representatives are listed on the inside front cover of this book.

Program:

This year's theme is, *Solar Maximum 2013 – How Space Weather Will Affect You!* We will again follow a panel session format, including brief presentations by the expert panelists followed by ample time for lively exchange across a diverse group of attendees. The complete agenda is provided separately.

Sessions:

What is Space Weather and Why it Matters: As we enter into a period of increased activity as part of the 11-year solar cycle, space weather events will become more frequent and intense. This session will describe the nature of space weather and how it affects you in your daily lives. The panelists will highlight recent spectacular solar events and their impact on Earth and our vulnerable critical technical infrastructure.

Critical Infrastructure Protection, Mitigation, and Response: We depend on critical systems and activities affected by space weather, such as the electric power grid, communications, positioning and navigation, and national security. These effects must be understood, mitigation actions developed, and acceptable levels of risk assessed to build and support an informed and resilient society. This session covers the main areas in which space weather can have a significant impact on our modern technological society.

The Unified National Space Weather Capability: Over the past year, the Federal agencies engaged in the National Space Weather Program have been working to establish closer coordination in providing space weather science, research, and services to our Nation. The Unified National Space Weather Capability—the focus of this session—is seeking to achieve maximum efficiency and effectiveness in the provision of space weather services, research, and technology to our customers and stakeholders.

Responding to New and Emerging Extreme Events: This session will examine the challenges and opportunities, regarding raising the awareness and understanding of space weather impacts on daily life, national security, the global economy, infrastructure, and business continuity. It will highlight the current means of providing space weather information to the public and examine the nature of public response to extreme environmental events.

Keynote Address

Dr. Cora Marrett

Deputy Director, National Science Foundation

Cora B. Marrett is Deputy Director of the National Science Foundation. Since January 2009, she has served as NSF's acting Director, acting Deputy Director, and Senior Advisor, until her confirmation as Deputy Director in May 2011.

Before her appointment as acting Director, Marrett was the Assistant Director for Education and Human Resources (EHR). In EHR, she led NSF's mission to achieve excellence in U.S. science, technology, engineering and mathematics (STEM) education at all levels, in both formal and informal settings.

From 1992 to 1996, she served as the first Assistant Director for the Social, Behavioral, and Economic Sciences (SBE) directorate. Marrett earned NSF's Distinguished Service Award for her groundbreaking leadership of the new directorate.

From 2001 to 2007, Marrett was the University of Wisconsin System's Senior Vice President for Academic Affairs. She also served concurrently as Professor of Sociology at the University of Wisconsin-Madison. Before joining the University of Wisconsin, she was the Senior Vice Chancellor for Academic Affairs and Provost at the University of Massachusetts-Amherst.

Marrett holds a Bachelor of Arts from Virginia Union University, a Master of Arts and a doctorate from the University of Wisconsin-Madison, all in Sociology. She received an honorary doctorate from Wake Forest University in 1996, and was elected a fellow of the American Academy of Arts and Sciences in 1998 and the American Association for the Advancement of Science in 1996. In May 2011, Virginia Union University awarded Marrett an honorary degree as a distinguished alumna.

Luncheon Speaker

Dr. Tamara Dickinson

Senior Policy Analyst,
Executive Office of the President,
Office of Science and Technology Policy

Dr. Tamara Dickinson is a Senior Policy Analyst at OSTP and works on issues related to disasters (natural and man-made), critical infrastructure, NASA Space Science Programs, and space weather. She is on a detail from the U.S. Geological Survey where she served as the program coordinator for the National Geological and Geophysical Data Preservation Program and Geology Lab Program. Prior to joining the USGS, Tammy held several positions at the National Research Council, including Senior Program Officer for the Committee on Earth Resources, Acting Associate Director for the National Materials Advisory Board and the Board on Manufacturing and Engineering Design, Associate Director and Acting Director for the Space Studies Board. She served a three year detail at the National Science Foundation as the Program Director for the Petrology and Geochemistry Program. Tammy also served as the Discipline Scientist for the Planetary Materials and Geochemistry Program at NASA headquarters.

Dr. Dickinson has held research positions at NASA Johnson and Goddard Space Centers and the Smithsonian Institution Natural History Museum. Her research focused on the origin and evolution of lunar materials and meteorites.

Dr. Dickinson has a BA from the University of Northern Iowa and MS and PhD from the University of New Mexico.

Featured Speaker

The Honorable Trent Franks (R-AZ)
United States Representative

Congressman Franks is the U.S. Representative for Arizona's 2nd Congressional district, serving since 2003. The district includes the entire northwestern corner of the state, including Kingman and Lake Havasu City, but most of its vote is cast in the western Phoenix suburbs. He is a member of the House Armed Services Committee and serves on the committee's Strategic Forces and Emerging Threats Subcommittees.

He is Chairman of the Congressional Missile Defense Caucus and the Congressional EMP Caucus, and is the lead sponsor of H.R. 668, the SHIELD Act, which would harden our electric grid against the threat of either a naturally occurring or a weaponized electromagnetic pulse (EMP). He has regularly been featured as an expert on the subject of the threat posed to our electric grid by EMP, having been interviewed in a number of documentaries on the subject, as well as having served as a featured speaker at the international Electric Infrastructure Security Summits in both London and Washington, D.C.

Session Moderators and Panelists

Abstracts and Biographies

Moderator

Dr. Michael Morgan

Director of the Division of Atmospheric and Geospace Sciences

Dr. Michael C. Morgan is Director of the Division of Atmospheric and Geospace Sciences at the National Science Foundation. He is on an intergovernmental personnel act assignment from the University of Wisconsin-Madison (UW-Madison), where he is a professor in the Department of Atmospheric and Oceanic Sciences. Dr. Morgan's research focuses on the analysis, diagnosis, prediction, and predictability of mid-latitude and tropical weather systems. He has been chair of his department's Undergraduate program (2005-2007, 2008-2010) and chair of the Curriculum Committee of the College of Letters and Science at UW-Madison during the 2009-2010 academic year. While on sabbatical leave during the 2007-2008 academic year, Dr. Morgan was an American Meteorological Society/University Corporation for Atmospheric Research Congressional Science Fellow. During his fellowship year, he worked in the office of U.S. Senator Benjamin Cardin (MD) as a senior legislative fellow. His work in Senator Cardin's office focused on energy and environment issues. Dr. Morgan received his Ph.D. and S.B. degrees from the Massachusetts Institute of Technology.

Session 2: Space Weather and Why it Matters

Dr. Louis J. Lanzerotti
New Jersey Institute of Technology

From the advent of the first electrical technology in the mid-nineteenth century – the electrical telegraph – to today, the Earth's space environment and its variability, often referred to as "space weather", has played an increasingly important role in determining the design and operations of a vast array of electrical systems used in industries such as communications, electrical power, navigation, and exploration. The historical record demonstrates that often space weather processes provide surprises in the implementation and operation of new electrical technologies in these industries. The historical record also demonstrates that as the complexity of systems increase, including their interconnectedness and interoperability, they can become more susceptible to space weather effects. Over the decades, understandings of the solar and terrestrial space environments have grown in parallel with the increasing complexity of the systems affected by these environments. This growth in fundamental understandings has been necessary in order to design, implement, and operate systems under adverse space weather conditions. New understandings also permit the implementation of mitigation techniques on existing systems in order to prevent in so far as feasible deleterious space weather impacts. An interesting human aspect related to solar-terrestrial effects is that the time intervals between the most severe technical impairments are often longer that the leadership time of industry (and government) personnel, often resulting in complacency and disinterest until the next space weather problem occurs.

BIOGRAPHY

Louis J. Lanzerotti (B.S. University of Illinois; A.M., Ph.D. Harvard), retired Bell Laboratories Alcatel-Lucent (1965-2002), Distinguished Research Professor of Physics NJIT (2002-present). His principal research interests have included space plasmas, geophysics, and engineering problems related to the impacts of atmospheric and space processes and the space environment on space and terrestrial technologies. Much of his research has involved close collaborations with telecommunications service providers on commercial satellite and long-haul (principally transoceanic) cables. His research has also involved geomagnetism, solid earth geophysics, and some oceanography. This research has been applied to design and operations of systems associated with spacecraft and cable operations.

He has co-authored one book, co-edited four books, and is an author of more than 500 refereed engineering and science papers. He is founding editor for *Space Weather, The International Journal of Research and Applications*, published by the American Geophysical Union. He has seven patents issued or filed.

He has been elected a member of the National Academy of Engineering and of the International Academy of Astronautics (IAA). He is also a Fellow of the Institute of Electrical and Electronics Engineers (IEEE), the American Institute of Aeronautics and Astronautics (AIAA), the American Geophysical Union (AGU), the American Physical Society (APS), and the American Association for the Advancement of Science (AAAS). He is the recipient of two NASA Distinguished Public Service Medals, the NASA Distinguished Scientific Achievement Medal, the COSPAR William Nordberg Medal, the AGU William Bowie Medal, the IAA Basic Science Award, and the Antarctic Service Medal of the United States. Minor Planet 5504 Lanzerotti recognizes his space and planetary research, and Mount Lanzerotti (74.50° S, 70.33° W) recognizes his research in the Antarctic.

Session 2: Space Weather and Why it Matters

Dr. Carolus (Karel) J. Schrijver
Lockheed Martin Advanced Technology Center

All space weather has its origin below the solar surface, where an astrophysical dynamo generates a dynamic magnetic field that, when it surfaces into the solar atmosphere, causes changes in the Sun's brightness from X-rays to infrared, modulates the solar wind and the magnetic field that it carries, and emits pulses of highly energetic particles. A fleet of space-based observatories now looks at the entire Sun from different angles. The Solar Dynamics Observatory (SDO), launched in 2010, has changed the way in which astronomers study the Sun: with a thousand-fold increase in data rate relative to earlier observatories, measuring the atmosphere of the entire visible half of the Sun's surface to its high, hot atmosphere at high resolution in space, time, and energy, the life history of explosive magnetism is being measured and analyzed from beginning to end. New understanding about solar flares and coronal mass ejections is emerging by combining this unprecedented view with experiments in the virtual world. This work is revealing that the solar atmosphere works as a coupled system, in which eruptions and explosions in one region can trigger others in adjacent magnetic regions or even in regions a million miles away, with important consequences for the forecasting of space weather. The growing archives of solar, heliospheric, and geospace observations now also allow us to uncover often subtle but significant couplings between space weather and society's technological infrastructure. As scientists piece together the working of the Sun-Earth system, the broad appeal of the imagery of the X-ray and ultraviolet Sun – invisible to the unaided eye – brings an unfamiliar Sun to the attention of a large audience that is increasingly aware of the hazards posed by an unfamiliar force: the Sun's magnetism.

BIOGRAPHY

Karel Schrijver is an astrophysicist studying the magnetic activity of the Sun as the driver of space weather in the heliosphere and in geospace. He has worked on the quiescent, long-term evolution of the solar magnetic field as well as on explosive, eruptive phenomena. The slow changes in the Sun's magnetic field are important for our understanding of the Sun as a driver of Earth's climate system. Impulsive phenomena, such as solar flares and coronal mass ejections, can damage our technological infrastructure and thereby impact our safety and economy. In his work, he combines detailed observations of the Sun with measurements of a variety of other stars like the Sun and with records of solar activity stored in rocks and in ice sheets in order to better understand infrequent but high-impact solar explosions. He is exploring the impact of space weather on the US economy through the coupling of solar activity with the electric power grid.

He is currently a Lockheed Martin Senior Fellow at the Palo Alto, CA, Advanced Technology Center where he is the Principal Investigator of the Atmospheric Imaging Assembly (AIA) on the Solar Dynamics Observatory (SDO) [see http://aia.lmsal.com]. Earlier, he served as the science lead of the Transition Region and Coronal Explorer (TRACE), later taking over the function of its principal investigator from his close colleague, Alan Title. With George Siscoe, he set up the Heliophysics Summer School (http://www.vsp.ucar.edu/Heliophysics/) that, now in its 6th year, has taught almost 200 promising researchers in the field of the Sun-Earth connection about the origins and consequences of space weather throughout the solar system, and which resulted in the first textbooks on the complex coupled system of physical processes that shape our local cosmos.

He received his training at the University of Utrecht in the Netherlands, starting as a stellar astronomer. During his postdoctoral career he worked both in the US (for the University of Colorado and Lockheed Martin) and in Europe (for the European Space Agency), increasingly focusing on the Sun and its dynamic magnetism, and now – having moved permanently to the US in 1995 – on the consequences of that magnetism for society.

Session 2: Space Weather and Why it Matters

Mr. Charles Gay

Deputy Associate Administrator of the Science Mission Directorate
NASA Headquarters

Modern society depends heavily on a variety of technologies that are susceptible to the extremes of space weather — severe disturbances of the upper atmosphere and of the near-Earth space environment that are driven by the magnetic activity of the Sun. Strong electrical currents driven in the Earth's surface during auroral events can disrupt and damage modern electric power grids and may contribute to the corrosion of oil and gas pipelines. Changes in the ionosphere during geomagnetic storms driven by magnetic activity of the Sun interfere with high-frequency radio communications and Global Positioning System (GPS) navigation. During polar cap absorption events caused by solar protons, radio communications can be severely compromised for commercial airliners on transpolar crossing routes. Exposure of spacecraft to energetic particles during solar energetic particle events and radiation belt enhancements can cause temporary operational anomalies, damage critical electronics, degrade solar arrays, and blind optical systems such as imagers and star trackers used on commercial and government satellites.

Space weather research ties into the other science disciplines (Earth, Planetary and Astrophysics) within NASA's Science Mission Directorate (SMD) and to efforts of the Human Exploration and Operations Mission Directorate (HEOMD) which supports the International Space Station.

BIOGRAPHY

Mr. Charles J. Gay has served NASA in senior management positions for over ten years. He is the Deputy Associate Administrator for the Science Mission Directorate (SMD). He previously served as the Acting Associate Administrator for SMD and also as Deputy Director of the Office of System Safety and Mission Assurance at Goddard Space Flight Center. Mr. Gay also served as the Deputy Director of the Heliophysics Division at NASA Headquarters where he was responsible for programmatic development and implementation of NASA's solar physics and geospace science program. In 2005, he served as the Deputy Director of the newly formed Earth Sun System Division where he was responsible for the development and operations of over 50 spacecraft, spanning multiple NASA Centers, agencies, industry teams, and international partners. Through his leadership, NASA's Earth science and solar/geospace science spacecraft development programs were integrated into a single division.

In addition to his experience at NASA, Mr. Gay has over 20 years of experience in the aerospace industry. He served as Vice President of a division of Litton Advanced Systems, managing a space systems business. He also worked at Martin Marietta, Lockheed Martin, and Fairchild Space Company. He has experience with many successful NASA flight programs including TDRS, Magellan, TOPEX, Terra, and EO-1 in engineering and program management positions. Mr. Gay has received the NASA Public Service medal, a Silver Snoopy award, and a Presidential Rank Award for Meritorious Service.

Mr. Gay received a B.S. in Civil Engineering and an M.S. in Structural Engineering from the University of Maryland.

Session 2: Space Weather and Why it Matters

Colonel Daniel C. Edwards
Chief, Integration, Plans and Requirements
Directorate of Weather, Headquarters United States Air Force

"Space Weather Impacts to Department of Defense Operations"

This presentation will showcase four primary agents of space weather that impact multiple Department of Defense (DoD) operations. Solar flares emit bursts of ultra violet and x-ray radiation that can cause almost immediate high frequency radio blackout, Global Positioning System (GPS) geo-location errors, radar and satellite communications (SATCOM) interference, and low earth orbit satellite drag. Secondly, associated high energy charged particles can reach Earth within 15-30 minutes and cause satellite damage, launch payload failure, and pose a harmful radiation threat to high flying manned air and spacecraft. Thirdly, geomagnetic storms can interfere with space surveillance and missile defense radars, degrade GPS system accuracy, and cause spacecraft anomalies, orbital drag and power grid failures that jeopardize our critical infrastructure. Finally, equatorial and high latitude scintillation can disrupt SATCOM as well as GPS system targeting and positioning accuracy.

Air Force Weather is responsible for providing operational space weather support to all elements of the DoD. The Air Force Weather Agency carries out this mission with its 24/7 space weather operations center that supplies mission tailored products to warfighters around the globe. These products are intended to reach operational and tactical decision makers in order to mitigate the effects of space weather as well as provide space situational awareness of the near earth space environment.

BIOGRAPHY

Colonel Daniel C. Edwards is Chief, Integration, Plans and Requirements Division, Directorate of Operations, Deputy Chief of Staff, Operations, Plans and Requirements, Pentagon, Washington, D.C. The Division plans weather and space environmental support for the Air Force Weather (AFW) functional area, and oversees integration of technology and weather into command and control, mission planning, and other systems.

Colonel Edwards entered the Air Force in 1989 as a distinguished graduate of the Air Force Reserve Officer Training Corps at the University of Nebraska-Lincoln, Lincoln, Nebraska. He has been a wing weather officer, a reconnaissance weather officer, a flight commander, a Wing Executive Officer, a Field Operating Agency Branch Chief, a Field Operating Agency Division Chief, and a squadron commander. Colonel Edwards is from North Platte, Nebraska.

Session 3: Critical Infrastructure Protection, Mitigation, and Response

Moderator

Ms. Heather King

Executive Officer for the Program Executive Office
National Planning Coordination and Assistance / National Preparedness Directorate
Federal Emergency Management Agency

Ms. King presently serves as the Executive Officer for the Program Executive Office housed within FEMA and responsible for shepherding Presidential Policy Directive 8 / National Preparedness. Prior to this new role, she oversaw the development of Comprehensive Preparedness Guidance (CPG) for state, local, tribal, and territorial jurisdictions. Prior to joining National Planning Coordination and Assistance (NPCA) two years ago, she served in several capacities within DHS and FEMA, including the response and recovery lead for FEMA's then newly created Private Sector Division and program specialist for FEMA's Community Preparedness Division, where she provided subject matter expertise in program guidance, implementation, and evaluation of the Citizen Corps Program. Previously, she has served in various roles at the state and local levels to include: a public information officer during Presidential Disaster Declarations for the Virginia Department of Emergency Management, a researcher of criminal history records for the Virginia State Police, and a community preparedness organizer at the grass-roots level.

Ms. King holds a Bachelor of Science Degree in communications from Virginia Commonwealth University and is currently wrapping up her Masters degree in Public and International Affairs at Virginia Tech.

Session 3: Critical Information Protection, Mitigation, and Response

Mr. Micah J. Loudermilk
National Defense University

Secure Grid '11, hosted at National Defense University in October 2011, was the third in an ongoing series of exercises that National Defense University has conducted in conjunction with US Northern Command and the Department of Homeland Security on US power grid vulnerabilities. The most recent exercise focused on the potentially catastrophic effects a major geomagnetic storm would have on the nation's electrical infrastructure.

Designed as an interagency response endeavor, *Secure Grid '11* assembled a large number of government agencies and private actors with a stake in the US electrical grid and experience dealing with space weather-related issues to highlight areas where US and international improvement is needed to quickly and effectively react to short-notice warning that a severe space weather event is imminent.

Exercise participants focused on four main goals over the two day event: identifying and understanding the potential impact of a major geomagnetic storm on the US electric grid, exploring and socializing ways to minimize the impact of a major GMD event on critical infrastructure, examining and assessing processes and procedures for recovering from a catastrophic geomagnetic storm, and deconflicting roles and responsibilities between public and private agencies.

Ultimately, *Secure Grid '11* worked to identify preparedness gaps in plans to manage challenges associated with extended-duration power outages, added urgency to existing efforts to identify technology solutions to protect the US grid, and provided exercise lessons to stakeholders in US grid infrastructure. While recognizing that geomagnetic disturbances cannot be prevented, unlike other threats the tools and options are fully available, if taken advantage of, to mitigate and protect from the risks of such an event.

BIOGRAPHY

Micah J. Loudermilk is the Senior Research Associate for the Energy & Environmental Security Policy Program at National Defense University. His program work focuses primarily on the critical nexus between energy and national security as well as the significant defense-related energy problems that confront the US military in the 21st century. In 2011, Mr. Loudermilk also served as the Exercise Coordinator for *Secure Grid,* an ongoing joint venture between National Defense University, US Northern Command, and the Department of Homeland Security, which works to identify and study critical vulnerabilities in the US electrical grid including geomagnetic storms and EMP events in addition to cyber and physical threats.

Since joining National Defense University in 2010, Mr. Loudermilk has led numerous projects and conducted detailed analysis on the potential for major energy changes across the Department of Defense through renewable and alternative energy technologies, behavioral adaptation, and a greater push by DOD for energy innovations in the private sector. Additionally, Mr. Loudermilk has researched and written extensively on cybersecurity and strategy, national security policy, small-scale nuclear reactors, the future of nuclear power in the US, and European energy politics. He has hosted numerous conferences, roundtables, and wargames on these and other issues and is a regularly invited speaker on defense energy issues.

Prior to joining NDU, Mr. Loudermilk worked with the Center for Strategic and International Studies and holds a Master of Arts degree in International Relations from the University of Akron. He is under contract to National Defense University through Booz Allen Hamilton.

Session 3: Critical Infrastructure Protection, Mitigation, and Response

Mr. K Scott Pugh
Senior Advisor for Interagency Programs
Science & Technology Directorate
US Department of Homeland Security

DHS S&T has proactively worked with government and industry to improve national readiness to respond to severe space weather events through initiatives such as the following - funding the 2011 JASON study "Impacts of Severe Space Weather on the Electric Grid"; partnering with USNORTHCOM to plan, fund and conduct a 2011 interagency and industry severe space weather wargame at National Defense University and funding the development and recent rapid deployment demonstration of a prototype 345KV recovery transformer from an ABB manufacturing facility in St. Louis Missouri to a Centerpoint Energy substation near Houston Texas in less than one week.

BIOGRAPHY

Scott Pugh has worked in the DHS S&T Directorate since 2007 and has been a key contributor to multiple energy infrastructure security initiatives. He is currently a member of the White House OSTP Geomagnetic Induced Current Interagency Working Group and the Federal Smart Grid Task Force. In the civilian sector he worked at Rocky Mountain Institute with CEO Amory Lovins to implement the advanced energy initiatives described in the DOD-funded study "Winning the Oil Endgame" and served as a member of the Defense Science Board Energy Strategy Task Force producing the 2008 report "More Fight – Less Fuel". Scott is a retired Navy Captain who served as a nuclear submarine Commanding Officer and Naval Academy Director of Mathematics and Science. He is a physics graduate of the US Naval Academy and the US Naval Postgraduate School.

Session 3: Critical Infrastructure Protection, Mitigation, and Response

Dr. Michael Gregg
Professor of Oceanography, University of Washington

JASON

At the request of the Department of Homeland Security, during its 2011 Summer Study JASON examined the vulnerability of the North American electric grid to severe space weather and reported findings and recommendations in *Impacts of Severe Space Weather on the Electric Grid* (JSR-11-320, Nov. 2011, MITRE Corp., McLean, VA). We concluded that the response of the electric grid to strong coronal mass ejections (CMEs) is not understood well enough to make accurate damage estimates, e.g. that a major CME could leave large areas and millions of people without power for many months. Though the threat of severe damage, however, is real and calls for protective measures now. Finland and Quebec, both at greater risk than the U.S., demonstrate the effectiveness of mitigation. For example, following the experience of Hydro Quebec, for perhaps $100M the 1,000 most vulnerable U.S. transformers could be protected with neutral-current-blocking-capacitors protected by shunts.

Observations vital for space weather warnings are presently supplied by SOHO, ACE, and STEREO satellites. Developed for research rather than operational warnings, ACE is well past its design life, making essential its interim replacement in 2014 with the refurbished DSCOVR satellite. Longer term, more is needed, such as replacing DSCOVR with a constellation of low-cost vehicles in quasi-satellite orbits.
These could increase direct warning times to several hours, from an hour or less now, and greatly improve observations of CME structures as they pass earth. In addition, operational satellites are needed to maintain the three-dimensional views now provided by the STEREO research satellites.

During the study, we found several gaps between agencies in the space weather enterprise. These include inadequate coupling between Air Force and NOAA space weather organizations, inadequate transitions of predictive models from NASA to NOAA, and NERC not having access to DOE work on electric grid modeling.

BIOGRAPHY

Professor of Oceanography at the University of Washington, Gregg has been a member of JASON for 30 years. A group of academic scientists, mathematicians, and engineers, JASON provides technical advice to the U.S. government, principally by means of intensive summer studies that begin with briefings from government and academic experts.

Session 3: Critical Infrastructure Protection, Mitigation, and Response

Mr. Anthony Russo
Director National Coordination Office for Space-Based PNT

Like the Internet, GPS is an essential element of the global information infrastructure. The free, open and dependable nature of GPS has led to the development of hundreds of applications affecting every aspect of modern life. GPS technology is now in everything from cell phones and wristwatches to bulldozers, shipping containers and ATMs.

GPS saves lives by preventing transportation accidents, aiding search and rescue efforts, and speeding the delivery of emergency services and disaster relief. GPS is vital to the Next Generation Air Transportation System (NextGen) that will enhance flight safety while increasing airspace capacity. GPS also advances scientific aims such as weather forecasting, earthquake monitoring, and environmental protection.

Space weather has the potential to disrupt this essential activity. GPS signals pass through the ionosphere. Solar activity can distort these signals, causing accuracy errors. In addition, intense radio bursts from the Sun can overwhelm GPS devices.

BIOGRAPHY

Mr. Anthony Russo has served as the Director of the National Coordination Office for Space-Based Positioning, Navigation, and Timing since January 19, 2010. He is a Senior Executive Service (SES) official from the Research and Innovative Technology Administration (RITA), U.S. Department of Transportation.

Mr. Russo previously served as Deputy Director of the National Coordination Office, on assignment from the Department of Defense. He retired from military service as an Air Force Colonel in October 2009. His expertise is in policy development, requirements definition, planning, and budgeting for space-based systems, including the Global Positioning System (GPS). Mr. Russo is the former commander of the 527th Space Aggressor Squadron, which identified potential threats and vulnerabilities to GPS service and built effective countermeasures. His past assignments included leadership positions at Air Force Space Command, the Space Warfare Center, the Pentagon, and United States Strategic Command.

Session 4: The Unified National Space Weather Capability

Moderator

Dr. David Applegate

Associate Director for Natural Hazards
U.S. Geological Survey

David Applegate is Associate Director for Natural Hazards at the U.S. Geological Survey. In that role, he leads USGS hazards planning and response activities and oversees the Coastal & Marine Geology, Earthquake Hazards, Global Seismographic Network, Geomagnetism, Landslide Hazards, and Volcano Hazards Programs. He co-chairs the National Science and Technology Council's interagency Subcommittee on Disaster Reduction and co-leads the Department of the Interior's Strategic Sciences Group. Prior to joining USGS in 2004, he worked on science policy at the American Geological Institute for 8 years and before that served with the U.S. Senate Committee on Energy and Natural Resources as the American Geophysical Union's Congressional Science Fellow and as a professional staff member. Born and raised in Chambersburg, Pennsylvania, Applegate holds a B.S. in geology from Yale University and a Ph.D., also in geology, from the Massachusetts Institute of Technology.

Session 4: The Unified National Space Weather Capability

Dr. Kathy Sullivan

Assistant Secretary of Commerce for Environmental Observation and Prediction
National Oceanic and Atmospheric Administration (NOAA).

Rapid advances in space-based technology and widespread dependence on these systems have made people more vulnerable than ever to hazardous space weather. An extreme space weather storm today, would affect us much differently than it would have in the past.

The scope of effort required to address the challenges is beyond the capability of any single agency, so the U.S. Government has established a collaboration among its space weather agencies: the Unified National Space Weather Capability.

UNSWC will leverage agency efforts by aligning programs, enhancing communications, and opening opportunities for joint work that benefits the public. It will also help us to establish stronger linkages internationally that benefit the United States.

This presentation will focus on NOAA's contributions to UNSWC. Understanding and being prepared for space weather is a part of the National Weather Service-led campaign to Build a Weather-Ready Nation to protect lives and livelihoods.

BIOGRAPHY

On May 2, 2011, Dr. Sullivan was appointed by President Obama as assistant secretary of commerce for environmental observation and prediction and deputy administrator for the National Oceanic and Atmospheric Administration (NOAA). She is also serving as NOAA's acting chief scientist. She is a distinguished scientist, renowned astronaut and intrepid explorer.

As assistant secretary, Dr. Sullivan plays a central role in directing Administration and NOAA priority work in the areas of weather and water services, climate science and services, integrated mapping services and Earth-observing capabilities. She provides agency-wide direction with regard to satellites, space weather, water, and ocean observations and forecasts to best serve American communities and businesses. As Deputy Administrator, she oversees the smooth operation of the agency.

Dr. Sullivan's impressive expertise spans the frontiers of space and sea. An accomplished oceanographer, she was appointed NOAA's chief scientist in 1993, where she oversaw a research and technology portfolio that included fisheries biology, climate change, satellite instrumentation and marine biodiversity. Dr. Sullivan was the inaugural director of the Battelle Center for Mathematics and Science Education Policy in the John Glenn School of Public Affairs at Ohio State University. Prior to joining Ohio State, she served a decade as President and CEO of the Center of Science and Industry (COSI) in Columbus, Ohio, one of the nation's leading science museums. Dr. Sullivan joined COSI after three years' service as Chief Scientist.

Dr. Sullivan was one of the first six women selected to join the NASA astronaut corps in 1978 and holds the distinction of being the first American woman to walk in space. She flew on three shuttle missions during her 15-year tenure, including the mission that deployed the Hubble Space Telescope. Dr. Sullivan has also served on the National Science Board (2004-2010) and as an oceanographer in the U.S. Navy Reserve (1988-2006).

Dr. Sullivan holds a bachelor's degree in earth sciences from the University of California at Santa Cruz and a doctorate in geology from Dalhousie University in Canada.

Session 4: The Unified National Space Weather Capability

Dr. Fred P. Lewis
Director of Weather, Headquarters United States Air Force

"Department of Defense's Space Weather Services and Operations"

This presentation will describe the Air Force's role as the Department of Defense's (DoD) only Space Weather provider, highlight recent accomplishments, and explain how it contributes to the Unified National Space Weather Capability. Air Force Weather is responsible for providing operational space weather support to all elements of the DoD. The Air Force Weather Agency carries out this mission with its 24/7 space weather operations center that supplies mission tailored products for military operations around the globe. Their alerts, advisories, warnings, forecasts and other tailored products use a robust combination of ground and space-based sensor data and environmental models to enable more informed decision making by operational commanders.

Air Force Weather leverages partnerships with other agencies, including participation in the National Space Weather Program, to access all available space weather expertise for the upcoming solar maximum and beyond. The National Space Weather Program, to include the Unified National Space Weather Capability, is crucial to facilitating interagency coordination and data sharing for modernizing the nation's space weather capabilities.

BIOGRAPHY

Dr. Fred P. Lewis, a member of the Senior Executive Service, is Director of Weather, Deputy Chief of Staff for Operations, Plans and Requirements, Headquarters U.S. Air Force, Washington, D.C. As the Director of Weather, Dr. Lewis develops doctrine, policy, requirements, and standards to organize, train, and equip the weather career field to support the Air Force, Army, designated unified/subunified commands, and the Intelligence Community. He directs the 1,150-person Air Force Weather Agency located at Offutt Air Force Base, Nebraska and provides functional oversight of the more than a 4,300-person Air Force weather total force.

Dr. Lewis' government career began when he entered the Air Force through the ROTC program at the University of Arizona in 1972. While on active duty, he commanded a weather squadron and computer systems group in addition to serving in many weather and joint staff officer assignments. In December 1985, he became the first Air Force weather officer selected for space shuttle duty, but never flew due to the Challenger disaster. He served on the U.S. Transportation Command Staff, including two years spent as Director of the Joint Transportation Corporate Information Management Center.

When Dr. Lewis was previously assigned as the Director of Weather, he led efforts to implement a total force transformation of the Air Force's weather functional area to significantly improve weather support for operators worldwide. He retired from the Air Force in 2000 in the rank of brigadier general. Prior to assuming his current position, Dr. Lewis was Deputy Director of Distribution Portfolio Management, Command, Control, Communications and Computer Systems Directorate, U.S. Transportation Command, Scott AFB, Ill.

Session 4: The Unified National Space Weather Capability

Dr. Barbara Giles
Director, Heliophysics Division, Headquarters
National Aeronautics and Space Administration

Utility of NASA's Heliophysics Research Fleet for Space Weather Prediction

The past five years have seen a series of new spacecraft launched toward the goal of investigating the properties and mechanisms of the space environment. The missions – SDO, STEREO, Hinode, AIM, THEMIS, TWINS, IBEX, and the contributed instrument on the USAF C/NOFS mission – have yielded insights and information that are not only of research value, but provide a solid basis for the improvement of space situational awareness. These missions have provided a range of data with unprecedented resolution, spatial, temporal, and thermal, across a wide range of scales. The next three years should see the launch of two major strategic missions –RBSP and MMS – along with the Small Explorer, IRIS. These missions, and the distributed systems observatory they create in combination, are significant assets allowing our scientific community to achieve major advances in understanding and predicting the space environment.

BIOGRAPHY

Director of the Heliophysics Division, Dr. Giles earned her Ph.D. in Physics from the University of Alabama in Huntsville in 1993 and joined Marshall Space Flight Center where she was part of a team that built suborbital and spaceflight heliophysics instrumentation. Her research interests focused on the Earth's magnetosphere with emphasis on the ionosphere's contribution to magnetospheric dynamics. In 1998, Dr. Giles transferred to the Goddard Space Flight Center to pursue new flight mission opportunities. She stepped into the role of Deputy Project Scientist, and was promoted later to Project Scientist for the Polar and Radiation Belt Storm Probes (RBSP) missions.

In 2004, Dr. Giles came to NASA Headquarters as the Program Scientist for RBSP and led the science procurement for that mission. She was the Program Scientist for the Solar Terrestrial Probes Program (STP) and managed the procurement for the next Explorer Program missions. As the Heliophysics strategic planning lead at headquarters, she also charted the Division's course for the future by planning new missions to study the Sun, its effects on the Earth's space environment, and its influences out to the far reaches of the heliosphere.

Session 4: The Unified National Space Weather Capability

Dr. Richard Behnke
Head, Geospace Section, National Science Foundation

Together with the other agencies of the National Space Weather Program, NSF is leading an effort to develop a unified space weather operational capability to provide the best possible services to the Nation for the next solar maximum and beyond. The NSWP will produce a capabilities plan, including the near-term actions and a long-term roadmap, details of which will be unveiled at the Space Weather Enterprise Forum. NSF is responsible for maintaining the health of basic research in all areas of the atmospheric sciences. The Foundation supports theoretical, observational, and numerical modeling research with the goals of increasing fundamental understanding of space environment processes and improving space weather predictive capability. Research areas of emphasis are: (1) solar region evolution and eruptive events; (2) interplanetary transport; (3) magnetospheric physics and dynamics; (4) ionospheric physics and dynamics; and (5) upper atmospheric physics and dynamics. Knowledge of the processes that are fundamental to each of these areas is enhanced by a multi-disciplinary approach to investigating the basic mechanisms through which these areas interact.

BIOGRAPHY

Dr. Behnke received his PhD in Space Physics and Astronomy from Rice University in 1970.His research interests center on studies of the dynamics of the Earth's ionosphere using incoherent scatter radar techniques.

Dr. Behnke joined the National Science Foundation in 1982. Presently, he is Head of the Geospace Section in the Division of Atmospheric and Geospace Sciences where he leads a Section that emphasizes forward-looking and transformative basic research in aeronomy, magnetospheric physics and solar physics.

Dr. Behnke is a co-chair of the Committee for Space Weather of the National Space Weather Program.

Session 4: The Unified National Space Weather Capability

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

"Space Weather and the 2013-2022 NRC Decadal Survey in Solar and Space Physics"

National Research Council (NRC) decadal science strategy surveys provide decade-long retrospective and forward-looking assessments of the status of and outlook for a research field, and they provide broadly based recommendations for explicit scientific and programmatic priorities for future investments in the field. Nearly two years ago, at the request of NASA and the NSF, the Space Studies Board of the NRC began a decadal survey to guide initiatives in solar and space physics ("heliophysics") during the ten-year period beginning in 2013. Release of a pre-publication version of the decadal survey committee's final report is expected by mid-July 2012. This presentation will provide an overview of the issues considered by the survey that have particular relevance to national space weather science and technology planning efforts.

BIOGRAPHY

Art Charo is the senior staff officer at the National Research Council supporting the work of the Space Studies Board's Committee on Solar and Space Physics and Committee on Earth Science and Applications from Space. Since joining the NRC in 1995, he has directed studies that have resulted in over 30 reports, notably the first NRC decadal surveys for solar and space physics (2002) and Earth science and applications from space (2007).

Dr. Charo received his Ph.D. in physics from Duke University in 1981 and was a post-doctoral fellow in chemical physics at Harvard University from 1982 to 1985. He then pursued his interests in national security and arms control at Harvard University's Center for Science and International Affairs, where he where he was a fellow from 1985 to 1988. From 1988 to 1995, he worked as a senior analyst and study director in the International Security and Space Program in the Congressional Office of Technology Assessment (OTA).

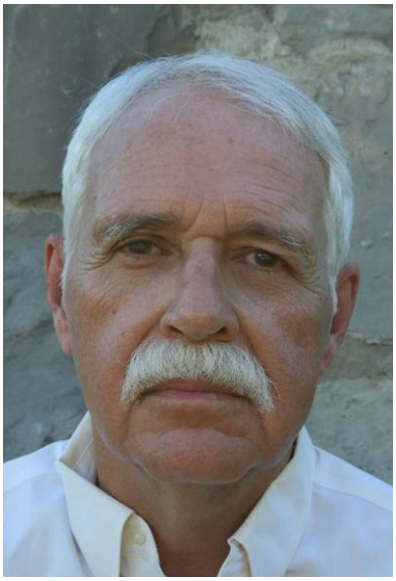
Dr. Charo is a recipient of a MacArthur Foundation Fellowship in International Security (1985-1987) and a Harvard-Sloan Foundation Fellowship (1987-1988). He was the 1988-1989 American Institute of Physics AAAS Congressional Science Fellow. In addition to his contributions to NRC reports, he has authored research papers in molecular spectroscopy; OTA reports on Earth observations from space and strategic arms control and verification; and the monograph, Continental Air Defense: A Neglected Dimension of Strategic Defense (University Press of America, 1990).

Session 5: Responding to New and Emerging Extreme Events

Moderator

Dr. Robert E. O'Connor

Program Director, Decision, Risk and Management Sciences
Division of Social and Economic Sciences
Directorate of Social, Behavioral and Economic Sciences
National Science Foundation



Since 2001 Robert O'Connor has been directing the Decision, Risk and Management Sciences Program at the National Science Foundation. At NSF O'Connor also serves on the management teams for the Decision Making under Uncertainty for Climate Change centers and two competitions: Water Sustainability and Climate, and Partnerships for International Research and Education.

Dr. O'Connor represents the National Science Foundation on the National Climate Assessment and Development Advisory Committee, a federal advisory committee that is preparing the National Climate Assessment. He also serves on the Subcommittee on Disaster Reduction of the National Science and Technology Council of the Executive Office of the President.

Prior to coming to NSF, Dr. O'Connor was a Professor of Political Science at the Pennsylvania State University where he also was part of the senior management team for the Center for Integrated Regional Assessment. The U.S. Department of Energy, U.S. Environmental Protection Agency, the National Oceanographic and Atmospheric Administration, and the National Science Foundation funded Dr. O'Connor's research into public perceptions of cumulative, uncertain long-term risks such as climate change.

His most recent articles have appeared in the *Agricultural and Resource Economics Review, American Journal of Political Science, Climate Research, Global Environmental Change, Journal of Environmental Education, Journal of Natural Resources and Life Sciences Education, Local Environment, Risk Analysis,* and the *Social Science Quarterly.* Dr. O'Connor earned his undergraduate degree at Johns Hopkins University and his doctorate in political science at the University of North Carolina at Chapel Hill.

Session 5: Responding to New and Emerging Extreme Events

Dr. Genene Fisher
NOAA National Weather Service

The rapid advances in the technology sector and our fast growing dependency on space-based systems have resulted in an ever-increasing vulnerability to space weather. NOAA is addressing these rapid changes in our space weather customer base by understanding and responding to the evolving needs and requirements of a global high-tech economy. The rapidly growing customer base requires improved forecasting skills to support the diverse user areas, including national security, aviation, emergency response, communications, global positioning system (GPS) applications, spacecraft operations, space exploration, and electric power grids. This presentation will focus on recent advances in the Space Weather Prediction Center (SWPC) services and how NOAA is working closely with industry, agency partners, and international organizations to increase awareness of how space weather can disrupt critical infrastructure and prepare the nation for responding to space weather events. An overview of the new Unified National Space Weather Portal will also be provided.

BIOGRAPHY

Dr. Genene Fisher, Senior Advisor for Space Weather at the NOAA National Weather Service (NWS), is responsible for leading space weather policy and programmatic activities within NWS HQ. She integrates space weather operations into agency policies and procedures and is expanding space weather related activities within NWS HQ. She collaborates with other federal agencies, private companies, academia, and international organizations to help build resilience of our critical infrastructure to solar storms. Genene currently serves as co-chair for the National Space Weather Program Committee on Space Weather.

Previously to joining NOAA, Genene spent ten years as a Senior Policy Fellow at the American Meteorological Society's Policy Program, where she focused on space weather policy issues and societal impacts. Genene worked closely with industry, including the GPS and aviation communities, on how to integrate space weather information into operations. She routinely met with policy makers to highlight the importance of space weather and offered recommendations on how to reduce adverse impacts to customer systems. She successfully expanded space weather activities within the AMS organization, resulting in the formation of the Space Weather STAC Committee and the annual Space Weather Conference. At the AMS, Genene also developed science policy curriculum material to educate the next generation of scientists in the policy process. She taught science policy courses as an adjunct professor at several universities.

Genene has a PhD in Atmospheric and Space Science and a Masters of Public Policy from the University of Michigan. She also has a BA in Planetary and Space Science from Boston University.

Session 5: Responding to New and Emerging Extreme Events

Dr. Phil Evans
Government Services Director, United Kingdom Meteorological Office.

I will discuss how space weather awareness has developed over recent years within in the UK and how far the UK has progressed in terms of understanding the risks and how it intends to mitigate those risks. Provide an update on developments within the Met Office and our growing relationship with NOAA SWPC.

I will then draw parallels between space weather and other environmental hazards, in particular looking back at the 2010 Icelandic volcanic eruption and the lessons we have learnt from that incident. This will focus on how to work effectively with the media, particularly focusing on the impact of the hazard and not the hazard itself. Also how the public validate information by looking at different sources and the need for consistency to support this behaviour.

BIOGRAPHY

I have worked for the Met Office since 1988. I initially worked in research and development on ground based remote sensing systems. Since then I have held a number of roles including responsibility for Strategy and Planning, Business Development, Commercial and International relations and most recently as the Met Office's Chief Advisor to Government.

I am responsible for all of the services the Met Office provides within the public sector from predictions of climate change advice on the spreading of airborne animal diseases to the 'free at the point of use' services we provide to emergency responders and the general public.

Session 5: Responding to New and Emerging Extreme Events

Dr. Geoff Crowley
Atmospheric & Space Technology Research Associates (ASTRA) LLC

Accurate knowledge of the ionospheric and thermospheric environment of the Earth's upper atmosphere are required in order to understand and predict their impacts on operational systems. The ionosphere affects vital radio-based systems, including communications, navigation, and surveillance systems. The thermosphere affects satellite orbits and spacecraft maneuvers. Over the past decade, our understanding of space weather and our ability to produce simulations and measurements of space weather phenomena have both developed to a remarkable degree.

In concert with this growth of knowledge, a community of commercial space weather providers has sprung up. The commercial providers offer various space weather services that extend from the Sun to the earth's atmosphere, including ionospheric and thermospheric effects that are of interest to operational systems. The commercial providers recently formed the American Commercial Space Weather Association (ACSWA) - www.acswa.us.

This presentation describes ACSWA, and some of the scientific and engineering capabilities of ACSWA members. The small companies that comprise ACSWA have world-class capabilities that can contribute to the national infrastructure, and our response to extreme events. This presentation will cover modeling and simulation, instrument development, smart-phone Apps and future directions of the US commercial space weather community.

BIOGRAPHY

Geoff Crowley is the CEO and Chief Scientist for ASTRA LLC. ASTRA performs fundamental research in space science, and develops new technology and applications for customers based on our scientific knowledge.

Prior to founding ASTRA, Dr. Crowley worked in four large organizations: NCAR, AFRL (as a contractor via U.Lowell), JHU-APL and SwRI, where he performed fundamental research on various areas of space physics and space weather. He has published over 100 scientific articles on his research. He is best known for his work on the thermospheric neutral gas at high latitudes, including his discovery of the cellular structures that occur there, and his modeling of high density features in the cusp region for the first time.

He is the Principal Investigator on the NSF-funded Cubesat mission called "Dynamic Ionosphere Cubesat Mission (DICE)", which launched in October 2011 on a NASA satellite from Vandenberg Air Force Base. He recently led the development of a commercially available GPS-based software-defined space weather monitor that measures the ionospheric total electron content (TEC) and scintillation parameters that affect communications, navigation and surveillance systems. He also developed an HF radio sounding system for mapping traveling ionospheric disturbances in the ionosphere. ASTRA has developed several smart-phone Apps for the delivery of space weather information on Apple and Android platforms.

Dr. Crowley was a co-founder of the American Commercial Space Weather Association (ACSWA), and currently serves on the Executive Committee of ACSWA.

Session 5: Responding to New and Emerging Extreme Events

Dr. Brenda Phillips

Professor, Center for the Study of Disasters and Extreme Events, Fire and Emergency Management Program (FEMP) Graduate Student Coordinator, Department of Political Science Oklahoma State University

For most of the population, disaster preparedness of any kind ranks low among many competing priorities. Yet improving response to hazard information, particularly warnings and protective action, requires dedicated, sustained preparedness outreach, education and - most importantly - action. A number of barriers to each of these efforts exist, particularly for under-resourced households and historically disadvantaged populations. This presentation discusses preparedness issues and principles for those most likely to be at risk for space weather impacts and draws upon scientifically-supported best practices for increasing awareness across socially vulnerable populations. Points of intervention are presented within existing initiatives, across key partners and within the context of people's daily lives.

BIOGRAPHY

Brenda Phillips is a Professor at Oklahoma State University. She is the lead editor of *Social Vulnerability to Disasters* (CRC Press) and the lead researcher for *Effective Emergency Management: Making Improvements for Communities and People with Disabilities*, (National Council on Disability). Her textbooks include *Introduction to Emergency Management* and *Disaster Recovery* and her published research can be found in a wide variety of scientific journals. Dr. Phillips teaches courses on high risk populations, community relations, disaster recovery and mitigation, research methods and international relief in the Fire and Emergency Management Program at Oklahoma State University.

Forum Summary and Wrap-up

Dr. Paul D. Try, Colonel, USAF (Ret.)
Senior Vice President and Program Manager, Science and Technology Corporation

Dr. Paul D. Try is Senior Vice President and Program Manager at Science and Technology Corporation (STC), and recent past Director of the International Global Energy and Water Cycle Experiment (GEWEX) Project Office (IGPO) of the World Climate Research Programme (WCRP). He received his Ph.D. in atmospheric sciences from the University of Washington with specialization in radiative transfer/remote sensing. Dr. Try's over 35 years as a professional in environmental sciences encompasses the full range of experience from operational and research project support, through leadership of international projects, and includes many years of leadership in the policy direction of both US and international environmental science organizations. He has extensive expertise in high level multi-agency research management as well as atmospheric physics, modeling and simulation, remote sensors (satellite and radar), atmospheric propagation, and support to military satellite and precision guided munitions employment.

Prior to joining STC, he served as Chief of Staff of the U.S. Air Force Air Weather Service and, also, Director of Environmental and Life Sciences in the Office of the Secretary of Defense where he provided oversight management of all DOD research and development in the environmental sciences, chemical/biological defense, medical capabilities and multi-service training. He also provided command as well as advisory support to a broad array of DoD Satellite operations, including direct support to the National Reconnaissance Office (NRO) and special support for precision guided munitions employment.

Dr. Try's recent program management and direct support activities with STC include acting as Director of a NASA funded International Project Office, support to the Office of the Federal Coordinator For Meteorological Services and Supporting Research (OFCM), management of meteorological satellite processing and application support activities for NOAA's National Environmental Satellite Data and Information Service (NESDIS), management of three research support efforts at laboratories of NOAA's Office of Atmospheric and Oceanic Research -- Environmental Technology Laboratory, Air Resources Laboratory, and Forecast Systems Laboratory, and oversight of support to Naval Research Laboratory and Air Force Geophysical Laboratory research efforts.

As Chief of the VELA Nuclear Detection Satellite environmental readout site in the 1970 timeframe, he provided some of the first satellite space weather observations of solar wind and high energy particle measurements to manned and unmanned space systems for numerous space projects. Dr. Try retired from the US Air Force as a Colonel, is a fellow of the American Meteorological Society (AMS), and was President of the AMS in 1996-97. Dr. Try has recently served on four committees of the National Academy of Sciences.

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