

Space Weather Advisory Group (SWAG)

Virtual Public Meeting

Meeting Minutes

Monday, June 13, 2022

10:00 AM – 2:00 PM

Meeting Attendees

Committee

Nongovernmental End User Representatives

Dr. Tamara Dickinson, Committee Chair, Science Matters Consulting

Mr. Mark Olson, North American Electric Reliability Corporation

Mr. Michael Stills, United Airlines (retired)

Mr. Craig Fugate, One Concern

Dr. Rebecca Bishop, Aerospace Corp.

Commercial Sector Representatives

Dr. Jennifer Gannon, Computational Physics, Inc.

Dr. Conrad Lautenbacher, GeoOptics, Inc.

Dr. Seth Jonas, Lockheed Martin

Dr. W. Kent Tobiska, Space Environment Technologies

Dr. Nicole Duncan, Ball Aerospace

Academic Community Representatives

Dr. Tamas Gombosi, University of Michigan, Ann Arbor

Dr. Delores Knipp, United of Colorado, Boulder

Dr. Scott McIntosh, National Centers for Atmospheric Research

Dr. Heather Elliott, Southwest Research Institute

Dr. George Ho, Johns Hopkins University Applied Physics Laboratory

Designated Federal Officer

Dr. Jennifer Meehan, National Space Weather Program Manager, National Weather Service

White House Space Weather Operations, Research, and Mitigation Subcommittee Principals

Dr. Ezinne Uzo-Okoro, Co-Chair, Office of Science and Technology Policy

Ms. Mary Erickson, NOAA

Mr. Bill Murtagh, NOAA

Dr. Elsayed Talaat, NOAA

Dr. James Spann, NASA

Dr. Jesse Woodroffe, NASA

Mr. James Platt, DHS

Mr. Mark Allen, USAF

Dr. Anil Rao, USAF

Meeting Minutes

10:00-10:05: Welcome (Dr. Jennifer Meehan, SWAG DFO)

Dr. Jennifer Meehan welcomed everyone to the third Space Weather Advisory Group (SWAG) meeting, in which they continued discussion on how best to implement Section 60601 of the Promoting Research and Observations of Space Weather to Improve the Forecasting of Tomorrow (PROSWIFT) Act.

Dr. Meehan provided a brief review of the PROSWIFT Act, which directs the National Oceanic and Atmospheric Administration (NOAA) to establish the SWAG to advise the White House Space Weather Operations Research and Mitigation (SWORM) Subcommittee. The meeting minutes from March have not yet been posted or circulated for SWAG review. As of May, the SWAG officially has a budget for FY2022, which will help with the much-needed contract support to run the meetings.

Since the last meeting, the SWAG has been hard at work on the PROSWIFT Act Directed User Survey, developing the questions sector by sector. The group has met several times since the last meeting in sector teams.

10:05-10:15: Opening Remarks and Recap of Meeting 2 (Dr. Tamara Dickinson, SWAG Chair)

Dr. Tamara Dickinson thanked the DFO, SWAG and SWORM members, and briefly reviewed the agenda for the day. Their goal is to get the user survey in to the review process at the Office of Management and Budget (OMB) directly following this meeting.

Dr. Dickinson gave a quick overview of what was discussed at the prior meeting. The Space Studies Board (SSB) Space Weather Roundtable has now kicked off, in addition to its Heliophysics 2024 Decadal Survey. Meeting 2 set the SWAG up well for its work over the last few months.

10:15-10:30: User Survey Discussion – Progress Since March (Dr. Tamara Dickinson, SWAG Chair)

Dr. Dickinson indicated that the sector leads have been meeting regularly and great progress has been made to-date. At the last meeting, a consensus was reached to prepare one or more scenarios to illustrate the possible impact of a space weather event. Additionally, a common set of questions were developed, including some that are sector-specific. The SWORM has been asked to provide input to those sectors. Ten sectors were defined to work on. Accordingly, the SWAG was divided into 10 sector-specific subgroups, with a lead for each of those. There was discussion about doing one of two pilots, but consensus has not yet been reached on which one. Sector-specific plans have been developed to conduct the survey. The results will be assimilated into one or more products.

The ten sector teams are: Space Traffic Management (STM), Aviation, Electric Power Grid, Global Navigation Satellite System (GNSS), Emergency Management, Human Space Flight, National Security, Radio Frequencies, Research, and Satellite.

Each team is comprised of a lead and several members. The leads of the teams met approximately six times with Dr. Meehan and Dr. Dickinson, and then they met with their individual teams several times. The teams were asked to define what their sector looked like. What was in the sector, what part of the sector should be surveyed, or should it be surveyed at all? They were also asked to develop a set of questions and to think about the process, whether it be scenario-based, an interview process, or a written survey. The sector groups have

completed their work for the most part. There may be some tweaking to do after the meeting. The set of questions has been sent on to the SWORM and to the National Weather Service (NWS) for input.

At the conclusion of the prior meeting, the plan was to base the questions more or less on the Abt Associates Conversational Guide. For the first several meetings of the sector leads, they worked to develop questions under the topics specified therein. The SWAG also looked at what the PROSWIFT Act asked it to do, which is to conduct a comprehensive survey of the needs of users of space weather products to identify: space weather research, observations, forecasting, prediction, and modeling advances required to improve space weather products. The group came up with an idea of how to tailor the Abt questions to meet the requirements of the PROSWIFT Act. They converted the Abt questions into baseline topics, added a few other topical areas to address all of the PROSWIFT Act issues that were not already addressed in the Abt survey questions, and then the sectors composed specific questions and scenarios under those baseline topics. Ultimately there were seven of those. This had the advantage of linking back to the Abt report, while allowing flexibility to address the six issues laid out in the PROSWIFT Act. It also provided flexibility between the sectors, such that all of the sectors did not have to be doing quite the same thing. There was initially a struggle getting all of the sectors to fit into the same box. One disadvantage is that each sector has their own set of questions and scenarios, which unfortunately means that there will be perhaps seven groups going through the Paperwork Reduction Act (PRA) process. It also does not ensure that there is equal depth of information in all of the sectors. However, Dr. Dickinson said that this discrepancy was to be expected in light of the fact that some sectors are more mature with respect to space weather than others.

The seven baseline topics the SWAG ultimately landed on are:

- (1) Current space weather observations, information, and forecasts utilized;
- (2) Current technological systems or components affected by space weather;
- (3) Current risk reduction and resilience activities;
- (4) Future space weather information required (communication methods, observations, and forecast products);
- (5) Future risk reduction and resilience activities;
- (6) New or non-traditional sources of space weather data;
- (7) Next-generation technologies, research, instrument and models to address space weather.

Each sector developed questions pertaining to each of these seven baseline topics. They determined their preferred survey type and then developed one or two top-level questions for each baseline topic. They then identified necessary sector-level questions for each topic area. All of the baseline questions will merge into common questions where possible as the SWAG moves downstream.

Next the SWAG looked at how to actually conduct the survey. For the first round, they will go through the PRA, which will happen for seven or eight of the sectors. In year two, the SWAG may take a second look at which parts of the sectors they want to focus on. In years 3 and 4, when the survey is conducted again, some different sectors will be covered that have decided to pass on the first round.

10:30-11:00: SWORM Update (Ms. Ezinne Uzo-Okoro, SWORM Co-Chair)

The PROSWIFT Act was designed to prepare and protect against social and economic impacts of space weather by supporting actions like identifying research needs, advancing space weather models, and promoting opportunities for research by engaging all sectors of the community. PROSWIFT also recognizes that before the adequacy of current federal government goals for accuracy, timeliness and quality of space weather observations and forecasting can be assessed, the end user community must first be surveyed to better understand what is needed to adequately prepare and respond to a space weather event. Feedback from the end users informs efforts to identify the need for specific technologies, methods and instrumentation to improve preparedness for space weather storms.

Breaking the SWAG's efforts up by end user sectors will help align its efforts with Administration priorities. The questions developed by the SWAG for the user survey will result in meaningful and actionable information, and will provide the insight sought to achieve a space weather-ready nation. The work of the SWAG will help move SWORM objectives forward and will help demonstrate the value of a community approach to addressing hazards with major global consequences.

OSTP recently reinstated the Orbital Debris Research and Development Group, to extend the work that was done by the previous Administration. An orbital debris research and development plan was released and an implementation plan has been under development that will be released shortly. The implementation plan outlines specific actions that the agency will engage on in the near term and the long term in three categories that affect orbital debris. The first part of the framework focuses on debris prevention before launch, the second on finding debris and improving uncertainty, and the third part focuses on remediating or repurposing debris. Active debris removal is a major component of that work. The SWORM has been engaging with the community through requests for information (RFIs) and listening sessions, and academic workshops, which will be released in the near future.

Ms. Uzo-Okoro gave an update on progress made from the 2019 National Space Weather Strategy and Action Plan. At the February 2022 SWORM meeting, she asked the SWORM members to assess if the objectives and actions are still relevant and aligned with current Administration priorities, as well as any other suggestions they might have. The SWORM working group leads are now coordinating the assessment, and they will consolidate and provide an initial brief of their findings at the next SWORM meeting in July. Ms. Uzo-Okoro invited the SWAG to contribute to this important initiative. OSTP and SWORM solicited community input for the 2015 strategy and action plan and again for the 2019 update. This was done through RFIs, notices in the Federal Register, and announcements at conferences such as the annual American Meteorological Society conference and the Space Weather Workshop in Boulder, Colorado. There was a lack of formal coordinated structure to get the feedback needed from industry and academia. Congress realized this, and to ensure that a structure was in place moving forward, the PROSWIFT Act directed the formation of the SWAG to ensure comprehensive and coordinated advice could be provided to the SWORM.

Ms. Uzo-Okoro welcomes the advice of the SWAG as the SWORM moves forward on its efforts to update the strategy and action plan. In particular, she is interested to know what is missing in the 2019 update. She asked that the SWAG considers the many policy and regulatory initiatives in place now, such as the 2021 Space Priorities Framework, the PROSWIFT Act, the OSTP Space Weather Priorities, and Executive Orders 13744 and 13865. At the National Academies Joint Meeting of the Space Studies Board and the Aeronautics and Space Engineering Board earlier in June, Ms. Uzo-Okoro presented some of the space weather activities that the SWORM would like

to see accomplished during the present Administration. She hopes to have a plan in place by the end of 2022 on how to move forward on the National Space Weather Strategy and Action Plan.

Dr. Delores Knipp asked if there is a list of initiatives and ongoing efforts documented on a particular website that the SWAG can access. Ms. Uzo-Okoro said they probably are not listed anywhere, as the SWORM only releases final products, and the orbital debris is ongoing. Similarly, the Space Weather Priorities developed by the Administration is an internal document that will eventually be shared through Dr. Meehan. Ms. Uzo-Okoro said that she will see what she can compile, but not all of the documents or initiatives are public at this point. Dr. Meehan promised to prepare a resource folder within the SWAG Google Drive; she will make sure that everything Ms. Uzo-Okoro mentioned is placed in that folder.

Dr. Kent Tobiska asked if the SWORM is also incorporating the U.S. Sector for International Standards, in particular the Technical Committee 20, Subcommittee 14 has a major international activity on orbital debris, both the mitigation of it working with IADC, and developing the international standards that are relevant to the orbital debris environment. Dr. Tobiska asked if the SWORM has had any contact with that group. Ms. Uzo-Okoro said they have not. In mid-April, Vice President Harris announced that the U.S. is banning anti-satellite tests. The orbital debris effort also aligns with that, where the U.S. is showing the international community what our standards are by leading first and developing them for our nation. At that point, the U.S. intends to move to international groups to push for adoption.

Dr. Seth Jonas asked about the importance of international contributions. He pointed out that things like scales and benchmarks might benefit from international input. Space weather is becoming more of a global issue as societies increase their reliance on technology. Dr. Uzo-Okoro agreed that with benchmarks and scale, we are stronger developing them in coordination with international partners.

11:00-12:00: Sector Subgroup Presentations and Discussions - Part 1

Space Traffic Management (Dr. Delores Knipp)

Space Traffic Management is a new sector, led by Dr. Knipp, that has not been surveyed in any of the previous user surveys. Because of the scope and the need to dig into the topic, the decision was made to table the Space Situational Awareness (SSA) component for a later time, as STM needs focused attention. There have been a number of white papers dealing with constellations and orbital debris. There are also ongoing STM efforts at the Space Weather Prediction Center (SWPC). There is broader community interest in STM, as well as a general increase in reliance on space operations. There are concerns about mega-constellations and collision avoidance, as seen in the Viasat report, "Managing Mega-Constellation Risks in LEO," published in January 2022. There is also commercial interest in Very Low Earth Orbit (VLEO). Additionally there are concerns about orbital debris, launch window availability, and space tourism. Dr. Knipp also cited a white paper by the Aerospace Corporation on STM.

There has been a major effort to get the user survey questions aligned with the other subgroups. The STM subgroup proposed that the format of the survey should be via interview, and it should be conducted with mature satellite operators, new players, constellation operators, and other interested parties.

In examining the seven common questions, Dr. Knipp pointed out that Questions 1, 2 and 3 pertain to current information, current technology, and current risk reduction and resiliency.

Questions 4 and 5 deal with future space weather needs, and Questions 6 and 7 cover either needed or anticipated innovations in terms of space weather support.

In terms of specific questions pertaining to the seven baseline topics, the STM subgroup asked:

- (1) Which environmental conditions and parameters are important for your application/system/component operations? Does your application/system/component consider space weather information in STM decisions? If yes, what information do you use? Where and how do you get the space weather information? Does your system monitor for relevant space weather conditions?
- (2) Which general aspects of system operations are affected by space weather? Please describe space weather effects for common and specialized activities.
- (3) What technological mitigation is used to reduce vulnerabilities or risk? What operational changes/mitigation is used to respond to adverse conditions? What other steps, not yet discussed, do you take to reduce risk and increase resilience? Have you developed and implemented a tabletop exercise to explore space weather sensitivities to severe or extreme geomagnetic storms? Do you consider NOAA space weather scales in your STM decisions? Are specific altitude or latitude regimes more problematic for your operations? Do any of your reduction/resilience activities rely on GNSS data availability?
- (4) What lead-times for space weather forecasts and products are needed to implement future operational mitigations? What type of information related to neutral density/drag issues and space/upper atmosphere conditions would be useful for operational mitigations, or technical mitigations?
- (5) How can operations be modified to compensate for periods of predicted or known space environment variations? What are the limiting factors to the proposed operation modifications? Are there known barriers or challenges to implementing the proposed mitigations? What other steps, not yet discussed, do you plan to take to reduce risk and increase resilience? What operational system improvements are required to compensate for neutral density or wind perturbations?
- (6) Do your operations produce new and/or nontraditional space weather data or models? What are they and how long is the information and/or data kept? Can this information be shared outside of the application, company, or community? If not, what are the challenges in doing so?
- (7) Are there any new technologies related to the application/component being developed that will mitigate known space weather impacts? Are there any current or planned collaborations with the environmental research communities focusing on improving the resilience of the application/component?

Dr. Jim Spann asked if Dr. Knipp saw the comments that were provided in advance of the meeting. Dr. Knipp said she saw the questions and assumed they were from Dr. Spann. She said that the direct wording questions where he suggested including temporal or spatial scale were an excellent suggestion, which she has included on her working copy of the document.

Dr. Tobiska added a footnote to Question 7 on the issue of modeling. Dr. Tobiska has been in discussions with groups associated with the Space Force and the High Accuracy Satellite Drag Model (HASDM) activities. He said it is pretty clear that it is still the Wild West in terms of the modeling, as there are so many different models being used. There is no consistency or common framework, which is a real detriment in particular. Dr. Tobiska emphasized that there is a great need for standardization.

Aviation (Mr. Michael Stills)

The Aviation sector, led by Mr. Stills, is one that has been familiar with some of the issues previously. There are some regulatory factors driving that, both in the U.S. and internationally. Based on the norm, outside of any current world issues, the questions were formulated using the framework. A lot of standard practices will go across commercial, private sector, government and military when it comes to operating aircraft around the world. The regulations that are in place are sometimes not very specific, and there are some that are more specific internationally as far as monitoring is concerned. Current industry practice is often to go across the various sectors of aviation. Mr. Stills' opinion is that it is fairly specific to the communication, navigation, and human factors that come into play.

In terms of specific questions pertaining to the seven baseline topics, the Aviation subgroup asked:

- (1) Does your enterprise utilize space weather observations, information or forecasts? If yes, is there a regulatory or policy requirement for your enterprise to utilize space weather observations, information or forecasts? What are the sources of space weather for your enterprise? Should Safety Management System (SMS) protocols be incorporated into space weather products and notifications?
- (2) Which systems or components of your operation or enterprise are affected by space weather?
- (3) What are the current risks to your enterprise or operation from space weather? How would you classify the risks? How would you assess the risks on a scale of severe to inconvenient? Does your enterprise or operation have policies or procedures to mitigate the risks currently associated with space weather? If any, what is the duration of actions directed by current policies and procedures? What precipitates an end to any actions implemented?
- (4) Does your enterprise rely on the SPWC website as the primary source of space weather? If so, should the Aviation tab remain as stand alone? If yes, should it be enhanced as directed by users? Does your enterprise use other sources of space weather? If so, which sources and for what purposes? What educational tools, formats, or vehicles would best assist the aviation sector to better understand space weather? Does your enterprise or operation foresee enhancements or changes to current information dissemination?
- (5) Does your enterprise or operation perform any simulations or exercises to enhance risk mitigation of future events? Does your enterprise or operation require new or other sources of space weather in order to mitigate risks?
- (6) Does your enterprise or organization utilize multiple sources of space weather information? If so, which sources and for what reasons?
- (7) What information or measurements would enhance monitoring of space weather for your enterprise or organization? Is there specific research that could produce such information? Would your organization deploy research, instrumentation or modeling activities itself to obtain that information, or rely on third party sources?

Electric Power Grid (Mr. Mark Olson)

Grid owners and operators in North America have been surveyed in the past with the Abt survey. There has also been a concerted effort among the owners and operators of the grid to use space weather information to be a more resilient grid with regards to the risk. The Electric Power Grid subgroup, led by Mr. Olson, sought to expand the scope of the Abt survey, which was designed for the grid operator and the SWPC. There are a lot of other things that the grid operators are doing in planning and engineering design to make the grid more resilient, and they are using space weather information to do that. That is a gap that the SWAG Power Grid Sector team looked to fill with this survey.

The grid operators are all required to be able to receive SWPC's alerts, warnings and forecasts, and use those for space weather operating procedures to reduce risk during an actual event. The grid is planned based on space weather information and there is a Federal Energy Regulatory Commission (FERC) reliability standard indicating that the North American grid has to be planned to a benchmark event that is based on historical magnetometer data. There are also tools that the grid planners use that are developed with ground conductivity modeling information to help with geomagnetically induced current (GIC) predictions. The survey will seek to collect data on how well these tools and this information fit their purpose for reducing the risk. The survey will help inform SWAG and SWORM on how the current products are used for grid resilience, and provide an opportunity for feedback on how they can be improved. It will also present an opportunity to hear which resilience activities grid owners and operators think they could do with a different product. The third goal is to find out what other data or information is used by the grid sector to reduce their vulnerabilities, and ascertain if that is available to the space weather community.

The proposed approach is interview-style. At the North American Electric Reliability Corporation (NERC), there are several different technical committees that bring together the owners and operators in different workshop formats that could be used to facilitate the exchange and collection of information on the surveys. Written surveys are also an option, but the primary focus is going to be on NERC technical committees.

In terms of specific questions pertaining to the seven baseline topics, the Electric Power Grid subgroup asked:

- (1) Do you consider space weather conditions in planning and operating the power system and equipment? If yes, what space weather information do you use and how do you get it? Do the space weather services that you use support engineering design or operations?
- (2) How does space weather affect systems and components needed for reliable operation of the power grid? How have the risks to power systems and components changed, if at all, and how does the changing risk inform the frequency that requirements for space weather resilience should be reviewed?
- (3) How is space weather information used in operating procedures to reduce risk and improve resilience of the power system to space weather? How is space weather information used for engineering designs that have been adopted to reduce risk and improve resilience of the power system to space weather?
- (4) What do engineers and operators within this sector need in future space weather information, and how will this information be used? What feedback do you have for providers of current products to help them meet your needs?

- (5) What additional actions could be taken with the help of improved space weather products, information or services? What may be limiting the power sector's ability to take these actions? How could better education and training improve capabilities?
- (6) What other data or information are used to support engineering design or operating actions that reduce risk from space weather, and how is it used? Do you monitor GIC or magnetic field data? For the above data, how long is it maintained, and can it be shared with the space weather community?
- (7) Are there any new technologies, research, instruments, or models that are needed to address space weather in the electric power sector?

Dr. Heather Elliott asked what range of forecast lead times and levels of reliability are useful for the given quantities that are used. She said she thinks it would help the research community out if that information can be drawn out. Mr. Olson said there may be more specificity in the written question, but he will double check on that. He said there were some findings in the Abt survey that were on target in terms of what the industry felt they would like for that.

Dr. Knipp asked if the intention is to focus mainly on U.S. providers in the survey. Dr. Meehan said that she does not think there are any limits or constraints, as space weather is a global issue. Mr. Bill Murtagh asked if Canadian grid users have been surveyed in addition to U.S. users. Mr. Olson said it would be natural to include both Canada and the U.S. in the surveys.

12:30-1:50: Sector Subgroup Presentations and Discussions - Part 2

Global Navigation Satellite System (Dr. Rebecca Bishop)

The Global Navigation Satellite System (GNSS) sector subgroup, led by Dr. Bishop, started with a document that listed communities or applications that were vulnerable. They looked at that, added more, and examined what part of GNSS data these communities are susceptible to. The applications are either dependent on precise timing or position/navigation. Within each of these focus areas, the GNSS subgroup broke them down into community groups. Precise timing communities include finance, communication networks, social service, manufacturing and distribution. On the position/navigation communities side, there is transportation, public safety and services, data markets, and land usage.

The GNSS subgroup is proposing that the GNSS survey takes place over two years. In year one, they plan to do three timing and two position/navigation community surveys. In year two, they plan to do two timing and two position/navigation community surveys. Because of how large and various the communities are, the GNSS subgroup is proposing a combination of web, paper survey, and individual in-depth interviews. One of the big challenges is locating enough people in each one of these communities so that they do not just get one opinion. It is equally important to get definitive information on areas that space weather does not impact as it is for the areas that it does, and by how much.

In terms of questions pertaining to the seven baseline topics, the GNSS sector subgroup came up with the following:

- (1) Which environmental conditions and parameters are important for your application/system/component operations? Does your application/system/component consider space weather conditions? If yes, what information do you use? Where and how do you get the space weather information?

- (2) Which general aspects of system operations are affected by space weather?
- (3) What technological mitigation is used to reduce vulnerabilities or risk? What operational changes/mitigation is used to respond to adverse conditions? What other steps, not yet discussed, do you take to reduce risk and increase resilience?
- (4) What lead-times for space weather forecasts and products are necessary to implement future operational mitigations? What type of information related to GNSS timing issues or space/upper atmosphere conditions would be useful for operational mitigations, technical mitigations, or both?
- (5) How can operations be modified to compensate for periods of predicted or known space environment variations? What are limiting factors to the proposed operation modifications? Are there any known barriers or challenges to implementing any of the proposed mitigations? What other steps, not yet discussed, do you plan to take to reduce risk and increase resilience?
- (6) Does your application/system/component monitor environmental conditions? What are they, how are they currently used, and how long is the information and/or data kept? Can this information be shared outside of the application, company, or community?
- (7) Are there any new technologies related to the application/component being developed that will mitigate known space weather impacts? Are there any current or planned collaborations with the environmental research communities focusing on improving the resilience of the application/component?

In terms of sector specific questions, the GNSS subgroup also asked:

- (2) Which GNSS constellations or other Radio Navigation systems are currently used and are expected to be used in the future, and what frequencies are utilized? Which components/systems depend on GNSS? At what point in the technological system or application is GNSS timing used, and at what point is it obtained? What type of receiver is used? What is the order of magnitude of the accuracies/precision and sampling rate required by the technological system and/or application? What is the order of magnitude of the accuracies/precision and sampling rate currently achieved by the technological system and/or application?
- (3) Does the technological system or application note degradation in GNSS timing values? How does it check? If yes, how often is a degradation noted? How often does it prevent the application from meeting minimum performance? What happens when the timing error exceeds the operational threshold requirement? Does the system depend on or use as a backup any other source of timing information?
- (5) How can operations be modified to compensate for periods of predicted or known timing errors? What software system improvements are required to compensate for timing errors? What hardware system improvements are required to compensate for timing errors? Are these actively being pursued? If so, what is the timeline to implementation?

Emergency Management (Mr. Craig Fugate)

Mr. Craig Fugate led the Emergency Management sector subgroup. Much of the systems or impacts to infrastructure are not things that the emergency management community owns,

controls, or manages. To a certain degree, they might not always be aware of what those consequences were.

In terms of specific questions pertaining to several of the seven baseline topics, the Emergency Management sector subgroup asked:

- (1) What space weather products do you currently use in your emergency planning? Have you run a space weather exercise? Do you have lessons to share?
- (2) Rather than a question, this should be a briefing on current space weather forecast tools and the impacts of space weather on critical infrastructure or systems for emergency managers.
- (3) Do current emergency plans account for effects of space weather in your jurisdiction? What information on space weather events do you require to update your emergency plans? Other than space weather forecasts and associated effects, what other information do you need to plan for space weather events and their effects on critical infrastructures or systems?
- (4) Based on the above questions, what additional space weather information and forecast timeframes need to be addressed for emergency managers?

Human Space Flight (Dr. Kent Tobiska)

The Human Space Flight sector subgroup, led by Dr. Todiska, has exchanged a number of emails and discussed several different iterations of how to approach the sector. When they looked at the Human Space Flight sector, the team tried to understand how the survey would be posed and who actually comprises this sector. Although it is expanding, human space flight is still a rarified activity and it is clear that there are both agency and commercial groups within the U.S. that this survey would be applicable to.

The first thing the team did was consider what groups they were looking at. There are groups at NASA working on the space station working on return-to-earth activities, in addition to other players in commercial space flight such as SpaceX, who recently had their own commercial astronaut go to space for a few days. Likewise, Blue Origin and Virgin Galactic have gone suborbital, and they are looking to launch orbital flights soon. Axiom is planning on developing a commercial space platform, and they are very active in that area. World View Enterprises also offers activities that go to near space in a high radiation environment using a stratospheric balloon. Additionally, groups like the U.S. Space Force 18th Space Defense Squadron are very interested in the human space flight component, although they are not yet sending individuals to space. Given the specific kinds of groups, it is clear that there are at least a half a dozen different human space flight activities both in the agency and commercial sector. The subgroup ultimately determined that an interview method would be the best format for their questions, as opposed to a general survey to a broad community.

In terms of questions pertaining to the seven baseline topics, the Human Space Flight sector subgroup asked:

- (1) Are there federal, state, corporate regulatory or policy requirements for your organization to use space weather observations, information and forecasts? Does your organization use space weather observations, information, or forecasts? What are the current sources of your space weather information?
- (2) What are the current vulnerabilities of your organization's systems to space weather? Does your organization have operations that are affected by space weather? Does your

- organization have space-based, atmosphere-based, or ground-based systems or components? How best can your organization's vulnerability assessment be supported?
- (3) What are the current risks to your organization's systems or operations from space weather? Does your organization use limits and thresholds to assess the impact of space weather on human health and equipment? Are there risks related to personnel/equipment safety, economic viability, or resilience? What is your risk management process for space weather?
 - (4) Would your organization incorporate currently unused agency, commercial, and academic sources of space weather? Which information from which sources? What enhancements or changes to current information dissemination does your organization envision?
 - (5) Does your organization use simulations or other activities to mitigate risk from future events? How does your organization analyze historical big events relevant to your activity? What different or new sources of space weather, not necessarily in existence yet, are needed by your organization to mitigate risks?
 - (6) Are there unused or new types of measurements or observations that would enhance space weather risk mitigation for your organization? Are there new types of modeling information that would improve space weather risk mitigation for your organization's operations? Would your organization develop research, instrumentation, and/or modeling activities itself to obtain that information, or would it look to other sources?
 - (7) What new or unused measurements or observations would enhance monitoring of space weather for your organization? What modeling information would improve space weather risk mitigation for your operation? Would your organization use research, instrumentation, or modeling activities itself to obtain that information, or would it look to other sources?

Research (Dr. Scott McIntosh)

Dr. McIntosh led the Research sector subgroup. He acknowledged the contributions of all of the other sector leads, as their efforts and documents helped shape the approach of the Research sector. The Research sector team was concerned about going to a universally open community and they concluded that the best approach would be an interview format with leaders and providers across a range of government and non-government sectors.

The Research subgroup compiled a list of examples for specific leaders to interview. There was emphasis on the aerospace industry, to include LM and Ball; research institutes and universities, to include NJIT, HAO, NSO, NRL, and LASP; DoD Space Weather Activities to include Space Command, AFRL, NRL, DARPA and AFW; NASA Heliophysics; NOAA SPWC; and NSF GEO/AGS. Results will be assembled and grouped for review by the SWAG research sector in a way that prevents attribution to individuals or entities. The idea is to try to touch a broad base and reach a consensus approach on the various questions.

Questions pertaining to several of the seven baseline topics, included:

- (1) Do you utilize space weather information in your enterprise? If yes, what information do you use and on which quantities are you most reliant/susceptible? What are the sources of your information? Have you identified improvements that could be made to that information that will improve your confidence? Are current data archives and curation methods adequate for your enterprise?
- (2) Which elements of your enterprise are potentially affected by space weather?

- (3) What are the current risks to your enterprise from space weather? What actions do you take to mitigate the effects of space weather on your enterprise?
- (4) Based on your answers above, what space weather information would advance your enterprise? What observational capabilities would be needed? What modeling capabilities would be needed? What software or hardware infrastructure might be required to produce that information? What educational tools, formats, or platforms would best assist in the communication of space weather information?
- (5) What future risks to your enterprise do you anticipate from space weather? What actions should be taken to mitigate those risks in your enterprise?
- (6) Are there other sources of space weather information that are not readily available to users, but could be broadly utilized? What would be required to transition those to wider availability?
- (7) What advances in capability would improve your understanding of space weather causes and effects? Are there particular observing, modeling strategies, or vantage points that will advance understanding of space weather causes and effects? Are there particular technologies that should be accelerated to improve understanding of space weather causes and effects? How should future space weather capabilities be coordinated to reduce duplication of effort and enhance collaboration? How can next generation capabilities be integrated to rapidly improve numerical models and space weather forecasts? Should next-generation capabilities be prioritized, and if so, how might that best be accomplished? What educational materials or approaches might be employed to improve scientific understanding and participation across the space weather research community? What educational materials or approaches might be employed to improve diversity in the space weather research community?

Dr. Bishop asked if space weather researchers will be interviewed from the organizations that were listed, or if the goal is to find specific aerospace or space engineering groups. She pointed out that some of the questions seem more suitable for space weather researchers, while others seem like they are more for a particular application. Dr. McIntosh said that is one of the reasons it took them so long to reach any convergence. He clarified that it is a balance of both, as there is a very broad set of requirements, and research is a very open topic. In particular, Dr. McIntosh is interested in talking to end users and practitioners about advances in research.

National Security (Dr. Seth Jonas)

The National Security sector subgroup, led by Dr. Jonas, is one of two sectors that will not be going forward for the time being. Based on meetings with the subgroup team, it was determined that the National Security sector overlaps with all of the other nine sectors. One thing that is unique about the National Security sector is that there is a mission application focus. It is really the integration and coordination of all of these technologies and other applications that go to completing or achieving the mission that is national security. In light of that, the National Security sector subgroup decided that it would be prudent to conduct the survey in the other sectors first to identify where there are gaps and opportunities. Upon the completion of Round 1, review and engagement will occur with the appropriate stakeholders, and a national security-focused endeavor can then be established to survey the appropriate stakeholders based on the gaps identified.

Radio Frequencies (Dr. Seth Jonas)

The Radio Frequencies (RF) sector subgroup, led by Dr. Jonas, also determined that it will not go forward at this time. Much like national security, there are many applications of RF. All nine of the other sectors use RF in some way to achieve their function, operation or mission. Taking a similar path as the National Security subgroup, the RF subgroup wanted to enable the technology and application sectors to conduct a first round of surveying to identify gaps that are not sufficiently covered that are RF application-specific. In a second round, those gaps will then be identified based on the survey results from Round 1. From there, the subgroup will identify what is application-specific to RF and address the gaps accordingly. One of the goals in doing so is to reduce duplication of efforts. Another goal is to focus on the applications and provide additional value-add based on what was missing in the first round.

1:50-2:00: Closing Remarks (Dr. Tamara Dickinson, SWAG Chair)

Dr. Dickinson briefly reviewed the agenda for the following day. She thanked everyone for their hard work and attention to detail. Dr. Meehan adjourned the meeting at 1:56 p.m.

Space Weather Advisory Group (SWAG)

Virtual Public Meeting

Meeting Minutes

Tuesday, June 14, 2022

10:00 AM – 2:00 PM

Meeting Attendees

Committee

Nongovernmental End User Representatives

Dr. Tamara Dickinson, Committee Chair, Science Matters Consulting
Mr. Mark Olson, North American Electric Reliability Corporation
Mr. Michael Stills, United Airlines (retired)
Mr. Craig Fugate, One Concern
Dr. Rebecca Bishop, Aerospace Corp.

Commercial Sector Representatives

Dr. Jennifer Gannon, Computational Physics, Inc.
Dr. Conrad Lautenbacher, GeoOptics, Inc.
Dr. Seth Jonas, Lockheed Martin
Dr. W. Kent Tobiska, Space Environment Technologies
Dr. Nicole Duncan, Ball Aerospace

Academic Community Representatives

Dr. Tamas Gombosi, University of Michigan, Ann Arbor
Dr. Delores Knipp, United of Colorado, Boulder
Dr. Scott McIntosh, National Centers for Atmospheric Research
Dr. Heather Elliott, Southwest Research Institute
Dr. George Ho, Johns Hopkins University Applied Physics Laboratory

Designated Federal Officer

Dr. Jennifer Meehan, National Space Weather Program Manager, National Weather Service

White House Space Weather Operations, Research, and Mitigation Subcommittee Principals

Ms. Ezinne Uzo-Okoro, Co-Chair, Office of Science and Technology Policy
Ms. Mary Erickson, NOAA
Mr. Bill Murtagh, NOAA
Dr. Elsayed Talaat, NOAA
Dr. James Spann, NASA
Dr. Jesse Woodroffe, NASA
Mr. James Platt, DHS
Mr. Mark Allen, USAF
Mr. Anil Rao, USAF

Meeting Minutes

10:00-10:05: Welcome (Dr. Jennifer Meehan, SWAG DFO)

Dr. Meehan welcomed SWAG members to Day 2 of the meeting and conducted the roll call. She turned the meeting over to Dr. Dickinson to give her opening remarks.

10:05-10:15: Opening Recap of Day 1 (Dr. Tamara Dickinson, SWAG Chair)

Dr. Dickinson thanked the SWAG and SWORM members for attending Day 2 of the meeting. She gave a quick recap of what occurred on Day 1 then briefly reviewed the agenda for Day 2.

10:15-10:20: Sector Subgroup Presentations and Discussions - Part 3

Satellite (Dr. Nicole Duncan)

The Satellite sector subgroup, led by Dr. Duncan, met and discussed the contents of the Abt report, and found it to be comprehensive. This was determined through their own subject matter expertise, as well as consultations with a few external experts in the field. Their comments were largely reflected in the report. Overall, spacecraft design and operational needs were reflected very well in the report. There were several limitations that the group discussed; first and foremost, that it was a small survey pool. In the report, they talked about only contacting two engineers and three operators. Of those that were surveyed, there was a commentary that they were "more sophisticated satellite companies" that were building for lower risk missions. Ultimately, the group was concerned about reaching a larger pool.

In light of how comprehensive the report was, the subgroup decided it would be best to re-survey this sector in the second tranche to allow the team to spend its time focusing on the areas that have not yet been surveyed. The subgroup also provided recommendations on what the survey group should look like going forward, to include a broader range of satellite builders, operations, and operational environments. It was not clear if all of the subsectors would have been represented in the small survey pool group, so things like higher and lower risk, commercial and government contractors, robotic and human missions, cis-Lunar, GEO, and Deep Space were also considered.

10:20-10:50: Input from NWS Social, Behavioral, and Economic Sciences Program (Ms. Valerie Were)

Ms. Valerie Were, a Social and Behavioral Science Program Analyst with the Cooperative Institute for Research in the Atmosphere (CIRA), led the discussion. Ms. Were provided initial comments on the questions that were shared with her and made minor editing suggestions. She liked that there were baseline questions that look across all sectors and is curious to see some of the feedback from others that have been invited to participate in the process. She is happy to work

with any of the sector leads individually to address comments or questions they might have about the feedback provided.

They have been preparing all of the collection instruments as they need to be submitted as part of the PRA. That process will involve Ms. Were working with the SWAG to prepare the Information Collection Request. The first and most critical step to starting the PRA clock is publishing a 60 day notice in the Federal Register, during which time public comment is invited regarding the necessity of this collection. Any comments received will need to be addressed individually. With other collections that have occurred in the past, they have looked at any specific comment that has come in, and a response was plugged into a table before submitting it back to the Paperwork Reduction Officer at NOAA, Department of Commerce, and then eventually to OMB. After the comments from the 60 day notice have been addressed, a 30 day Federal Register Notice will be published, in addition to submitting Supporting Statements A and B to OMB. OMB cannot conclude the review until that 30 day period has passed.

In preparing the 60 day Federal Register Notice, Ms. Were needs the following information from each of the sector leads: collection methods, number of potential respondents, and the estimated time per response. Ms. Were recommended keeping interviews to a maximum of about an hour; beyond that, it tends to be too much for both the interviewer and the interviewee. At a later point, Ms. Were will also need to receive a copy of the survey questionnaires and the interview guides themselves from each of the sector leads.

Dr. Tobiska indicated that his sector is planning to do interviews with small groups of people at different organizations. He asked if the organization would be considered one respondent, or would it be the actual number of individuals who were included in the roundtable discussions? Ms. Were said that interviews with a small number of participants would be considered a focus group. She said she would need to know how many focus groups there are, and how many people are in each focus group.

Dr. Bishop made a general comment that the number of respondents has not been discussed much as of yet. In past meetings, the SWAG concluded that the Abt report needed more interviews. Dr. Bishop suggested discussing what the SWAG considers an appropriate number of respondents in order to do a comprehensive survey in line with the charter. Additionally, how are those respondents going to be identified? One of Dr. Bishop's concerns is that the survey only ends up finding the people who already know a significant amount about space weather, which does not necessarily give a well-rounded view of the end users' needs relative to space weather. Ms. Were said it would be helpful to get a sense of how each sector is structured in order to provide more useful advice on how many respondents would be appropriate and how to identify them.

Dr. Meehan asked if the SWAG needs to live up to the number of respondents that is specified in the Federal Register Notice. Ms. Were confirmed that it is only an estimate. She said she has seen a collection where somebody estimated they would have 200 respondents but ended up with way more than that. The goal is to get as close as possible to the number specified in the Federal Register Notice, but at the end of the day it is understood that it is difficult to predict, so meeting an exact number is not required. The goal is to be comprehensive as the law requires.

Dr. Dickinson said that the SWAG will document some its concerns for Ms. Were going forward, and set up small groups of similar sectors with overlaps. Dr. Dickinson reminded all of the sectors that the SWAG are the ones conducting the survey. They are not hiring anybody, so if one of the sectors decides to interview 500 people, some number of the 15 SWAG members will have to

conduct those 500 interviews. Dr. Dickinson asked the sectors to keep that in mind when deciding how many people to survey.

10:50-11:30: Committee Discussion on Sector Questions and Processes (Dr. Tamara Dickinson, SWAG Chair)

Dr. Dickinson began the discussion by pointing out that the overall package is very close to being done. There are no major showstoppers in anything that the 10 sectors have laid out. She then opened the floor to both SWAG and SWORM members for discussion.

Dr. Bishop said that it would be good to have an introductory paragraph that describes the education part of space weather and puts it in context in a way that is tailored to each of the individual sectors. Dr. Dickinson agreed and asked if it is something each of the sector leads should develop. Dr. Bishop suggested that one person should draft the general portion and then circulate it around to the sector leads, as it is easier to edit content than it is to come up with it from scratch.

Mr. Olson said that Ms. Were's comments on the Word document have been helpful. In preparing the questions, the sectors started with a broad or open-ended type of question under each of the topical areas, and then they had bulleted lists of more probing questions. Mr. Olson reiterated Ms. Were's feedback that the open-ended question is really the interview question, and the subparts can be included in an interview guide for when the questions are asked, but it may not necessarily be worth asking for a response to each subpart. Some of the more specific sub-questions can be used for clarification or to prompt the respondent if they are stumped or struggling on a given topic. However, Ms. Were emphasized that in the ideal situation, the respondent is able to answer the questions without any leading.

Mr. Anil Rao asked if the idea is that the questions will be sent to potential interviewees prior to the actual interview. He said that on the Department of Defense (DoD) side, that may be advantageous, as the interviewees can then take a look at those questions and sort out who can speak best to each of the processes, which would minimize the number of people required. Dr. Bishop said she thinks it will depend on the sectors and who is involved. Dr. Knipp said that it is a great idea, specifically for DoD and other similar organizations. Ms. Were said it is also an option to send a pared down version of the questions and leave the probes out, just so they can get a sense of the questions being asked. The interviewer themselves would then have the full complement of questions and probes on hand at the time of the interview.

Dr. Hazel Bain, a SWORM subject matter expert and research scientist at SWPC, said that it is great that the SWAG is considering the education components before asking these questions. She said that you need that bit of back and forth in order to get the interviewees to dig in to an understanding. Dr. Bain also said that she thinks the detailed questions that build upon the Abt survey are great; however, there were common answers that were received in the Abt survey results. Having more detailed questions does not necessarily mean you will get more detailed answers. Many of the answers received previously pointed to high level, gold standard-type goals. She asked if the SWAG has thought about how to encourage more intermediate things that can be done. Three day forecasts, for instance, are many years away, but what can be done with forecasts that would have a more intermediate, achievable standard that could be provided for capabilities?

On the education component, Dr. Bain said it was a common theme that there was a need for more education. She asked if there were any questions exploring how people want the

education delivered in particular. Would test bed experiments from SWPC be useful, for instance? Dr. Bishop said she thinks that asking that question is part of the interview process, in addition to why. She said that part of it will be on the interviewer side to determine what the minimum they need is. Dr. Bishop also added that the compilation of the information received from all of the questions may provide insight on some of the topics Dr. Bain raised.

Mr. Olson emphasized that Dr. Bain's questions were really good. He said that one question the Electric Power Grid sector worked on sought to affirm or get perspectives on the Abt survey responses in particular. Mr. Olson said the Electric Power Grid sector would be looking to rehash some of the key findings from the Abt survey in a quick summary at the outset, and then ask the respondents if they agree or whether they would give any amplification to it. Mr. Olson said that could help to avoid getting the same information as the Abt survey.

Dr. George Ho said that besides just asking the questions, they really need to be diving a bit deeper. He said that in a way it is similar to how they develop various matrices for missions. Of course they want 24/7 coverage everywhere, but why? Dr. Ho said that the SWAG needs to be tactful in conducting the survey.

Dr. Jennifer Gannon asked if there will be time to go back and do some revisions now that the SWAG has heard many ideas from the other sectors. Dr. Dickinson confirmed that everyone will go back through and re-look at everything after the meeting, taking into account what they heard from the other sectors, the SWORM and Ms. Were, to see if there are any final edits or tweaks to the questions or the process in general.

Dr. Tobiska said that the Human Space Flight sector originally had seven questions that got consolidated down to six at the very end. He asked if they should go back and reinstitute the seventh question so that it is consistent across all sectors. Dr. Meehan recommended keeping with the seven baseline questions that each sector is putting forth. In instances where certain questions do not apply to a given sector, they can simply state that. This will make the report more consistent when it is ultimately distributed to Congress and the public.

Dr. Bishop made a motion to accept the topic areas and the seven baseline questions that have been discussed, with the stipulation that the comments from Ms. Were and the SWORM can be incorporated, in order to move forward with the PRA process. The motion was seconded by Dr. Gannon, and it passed unanimously.

11:30-12:00: Seeking Community Input (Dr. Tamara Dickinson, SWAG Chair)

Dr. Dickinson indicated that the SWORM would like the SWAG to seek community input. While some public comments will be fielded during the PRA process, the SWORM would like the SWAG to seek additional input from the community beyond that.

Dr. Dickinson and Dr. McIntosh submitted a proposal to AGU for a town hall in December 2022, and they are waiting to hear back about where it stands. Likewise, Dr. Dickinson and Dr. Meehan submitted a request for a session at AMS in Denver in January 2023, which is set to go forward. One of the things the SWAG will need to think through is who will speak at that session. There will be an overview and briefs from each of the relevant sector leads. The SWAG will need to determine which of the sectors are relevant to the AMS community. All of the participants will need to submit an abstract for the AMS session when the time comes. Other relevant upcoming meetings include SEASONS, Aviation Safety Infoshare, Airline Dispatcher Federation, Flight Safety Foundation, and NBAA (Biz Jets).

Dr. Bishop clarified whether the efforts to seek community input will include just the space weather community, or will the SWAG also try to engage end users from each of the sectors? Dr. Dickinson said the goal would be to do both where possible. Dr. Bishop also confirmed that she will be in Chicago at the AGU town hall in December 2022, and she volunteered to be added to the list of potential speakers. Dr. Bishop also mentioned ION and IEEE meetings, as well as CEDAR/GEM.

Dr. Gannon confirmed that she will be at both AGU and AMS, and she offered to support either. Dr. Gannon also highlighted an upcoming Ideas Lab workshop relating to the power grid that is being hosted jointly by NSF, NOAA and NASA. Dr. Jesse Woodroffe confirmed that the Ideas Lab is an attempt to build up new research solutions and technology-driven ideas for addressing GICs. More details on the Ideas Lab are expected to surface before the next SWAG meeting. Mr. Woodroffe estimated that it will likely occur somewhere in the August to September timeframe. Dr. Lisa Winter is the Program Manager at NSF who is coordinating the effort.

Mr. Olson shared that the NERC Geomagnetic Disturbance (GMD) meeting is taking place in September this year. He confirmed that he will help the SWAG get onto the agenda for that meeting.

Dr. Elliott mentioned the Triennial Earth Sun Summit (TESS), which is a researcher meeting that covers a lot to do with heliophysics. She asked if the SWAG can advertise to get people to participate in the survey. She said that email blasters might be able to reach way more people than just those who attend conferences. Dr. Dickinson said this is a good idea especially for surveys that are being conducted in a written format. However, for surveys conducted in a workshop or interview format, Dr. Dickinson warned that there could be a bandwidth issue.

Dr. Tobiska said that the Commercial Space Flight Organization is hosting an upcoming meeting that will be relevant to the Human Space Flight sector. He said that while his company Space Environment Technologies (SET) is not currently a member of that, they are considering becoming an associate member. Dr. Tobiska confirmed that he knows quite a few people involved in that effort, and he believes the SWAG could likely rely on some personal contacts to get an invite. He said that he thinks this might be an appropriate venue for the STM and Human Space Flight sectors to conduct a joint session.

Dr. Tobiska also mentioned that ISO is heavily involved in the standardization of the debris environment. They hold regular meetings throughout the year on orbital debris. NASA and a number of U.S. companies are a part of that U.S. Technical Advisory Group (U.S. TAG). Dr. Tobiska said that somehow there needs to be more of a convergence between what those organizations are doing and the SWAG's efforts. The debris problem is not exclusively a U.S. issue; therefore, it cannot be solved without international support.

Dr. Tobiska emphasized that the best conference to go to for Space Traffic Management is going to be the Advanced Maui Optical and Space Surveillance Technologies (AMOS) Conference in September. He said it is a little bit late to get into that session this year; however, the question could be raised with the organizers as to whether the SWAG could participate next year. The AMOS Conference is widely attended by approximately 800 people annually.

Other groups and events that were brought up in the chat include SWW, International Association of Emergency Managers, the National Homeland Security Conference, Space Symposium, and the Small Satellite Conference.

Dr. Bishop asked if it would be acceptable for volunteers to help with the interview process so that the 15 SWAG members do not have to conduct all of the interviews themselves. Dr. Meehan

said that a subcommittee can be established under the SWAG to help conduct those interviews. It is an option to form working groups under the SWAG; they would follow the same rules as the SWAG. Dr. Meehan added that several individuals who did not make it onto the SWAG indicated that they were interested in participating in working groups.

12:00-12:15: Public Comments and Continued Discussion

There were no public comments so discussion continued among the SWAG members.

Dr. Tamas Gombosi brought up the Heliophysics 2024 Decadal Survey. He said that the Helio Decadal is a critical effort that will determine priorities for NASA, NSF, and research priorities for NOAA SWAG. He said that it will be problematic if there is no coordination between the SWAG and the Helio Decadal. Dr. Dickinson said her understanding from the rumor mill is that the chairs and subcommittee chairs for those panels will be announced soon. Dr. Gombosi insisted that the SWORM should definitely be a part of the nomination process.

Dr. McIntosh added that the best plan might be to prepare a white paper that is signed by 12 to 15 private individuals. Dr. Meehan said she would support that, as the SWAG members are all representatives who are here to bring their perspectives from the industry. If there is something the group collectively would like to submit on behalf of the SWAG, Dr. Meehan highly recommends doing so.

Mark MacAlester submitted a public comment on behalf of the Cybersecurity and Infrastructure Security Agency (CISA), which is under the Department of Homeland Security. CISA has direct connections to the communications ISAC, which has all of the major players at the USTelecom. Mr. MacAlester indicated that he is happy to make the connection and leverage that for the SWAG.

12:45-1:00: Related Activities - Update (Dr. Tamara Dickinson, SWAG Chair)

NASEM Space Weather Roundtable

Dr. Dickinson gave a brief update on the National Academies of Science, Engineering and Medicine (NASEM) SSB's Space Weather Roundtable. The Roundtable is called out in the PROSWIFT Act. It is a government-university-commercial roundtable on space weather. They just recently announced their members. The charter and membership for the NASEM Space Weather Roundtable can be found on the National Academies' SSB website.

Collaboration and coordination between the SWAG and the Roundtable will be crucial. Both groups are working towards one common goal: to prepare and protect against the social and economic impacts of space weather phenomena. Dr. Dickinson has volunteered to speak at numerous meetings to get the word out about what the SWAG does. The SWAG is in the process of creating an invite list for its meetings, which would include the members and chairs of these other related groups. It has also been suggested that there should be administrative meetings between the SWAG, the Roundtable, and the Space Weather Council (SWC).

Mr. Bill Murtagh shared that the Space Weather Roundtable will have ex-officio members from each of the funding agencies. There have been some back and forth discussions on this. One goal is to make sure that there is not too much overlap; these bodies should complement each other. The ex-officio members will be SWORM members for all practical purposes. Mr. Murtagh also added that the Air Force Research Lab and the Naval Research Lab are both involved in the

Roundtable, which will mean greater representation of the national security elements at play. Dr. Knipp and Dr. Gannon are both members of the Space Weather Roundtable.

NASA Space Weather Council

The SWC is a subcommittee of the Heliophysics Advisory Committee at NASA. It is a community-based, interdisciplinary forum for soliciting and coordinating community analysis and input and providing advice. They have had one meeting thus far, and the Heliophysics PAC had one meeting after that.

1:00-1:55: Next SWAG Activity (Dr. Tamara Dickinson, SWAG Chair, and Mr. Bill Murtagh)

Dr. Dickinson went through and whittled down the list of future SWAG activities that were compiled at the prior meetings in order to prioritize certain tasks. Some of the suggestions seemed like they would be better if they were done after some of the user survey information came in.

The priority items identified by Dr. Dickinson are as follows:

- Advice on new elements and/or new emphases on National Space Weather Strategy and Action Plan
- Articulate the value of space weather observations, forecasting, and services; build constituency base
- Benchmarks, Space Weather Scales, and all clear notifications
- R2O2R -- Security and availability of data; make archived forecasts available for model validation

Mr. Murtagh said that when OSTP embarked on the development of the first strategy and action plan back in 2014-2015, they talked a lot about how to engage the community and get important input from all sides. They attempted to do so through various conferences and Federal Register Notices, but overall it was lacking a more formal process instead of ad hoc input coming from different bodies. The community outside the government recognized that, which was a huge part of why the SWAG was established by Congress.

SWORM working group leads will coordinate with their teams to conduct an assessment of the 2019 National Space Weather Strategy and Action Plan. The input will be consolidated, and an initial assessment will be provided at the next SWORM meeting. The due date for the complete assessment with recommendations will be determined at the July SWORM meeting.

Mr. Murtagh asked SWAG members to keep in mind the various policies and regulatory frameworks that are in place currently, including the PROSWIFT Act (2020), the OSTP Space Weather Administration Priorities (2021), the National Space Weather Strategy and Action Plan (2019), Executive Order 13744 on Coordinating Efforts to Prepare the Nation for Space Weather Events (2016), Executive Order 13865 on Coordinating National Resilience to Electromagnetic Pulses (2019), and the National Space Priorities Framework (2021).

Dr. Dickinson opened up the floor to the SWAG for questions and brainstorming on how best to go about providing input. One option is to run a workshop-type event. Another possibility is to hold an Industry Day before the SWAG.

Dr. Tobiska said that there are a lot of different atmosphere density models available. Because there are so many players out there, everyone is essentially using their own model. Some of the

18th Space Defense Squadron and NASA Conjunction Assessment and Risk Analysis (CARA) personnel raised the issue that because there is no standardization, it is very difficult to make specific recommendations to the commercial sector. In that area, there is both DoD and Department of Commerce taking on STM. Dr. Tobiska said it seems like this is input that the SWAG might make to the SWORM. Dr. Dickinson said she assumes the SWAG's input will be in the form of some sort of written document. If the SWAG also hosts some sort of a workshop as well, SWORM members could attend that and get things out of it that are not necessarily in a written document.

Dr. Bishop asked whether it would be an open workshop, or just a SWAG workshop. Dr. Dickinson said she believes it could be both. The SWAG could meet without any external speakers and do the brainstorming by itself, or it could host a meeting with panelists and speakers invited as more of an open workshop. Dr. Bishop said it might be good to have an initial meeting that was just the SWAG to determine which questions require specific input, and then the SWAG could host a secondary meeting where specific speakers are invited to inform the SWAG on its recommendations.

Dr. Jonas remarked that the list of policies that Mr. Murtagh presented is quite extensive. To help identify recommendations to prioritize as inputs to SWORM, Dr. Jonas asked if there is a process through which an understanding can be reached of what actions have been taken or are in progress across those policies. He said it would be helpful to figure out where we currently are on those particular frameworks. Dr. Dickinson asked if there is public information available about where the SWORM sits with respect to its actions and what has been accomplished to date. Dr. Meehan said this is something that the SWORM is evaluating right now. The SWORM objective leads will be reporting out on the progress to the co-chairs at its July meeting. Dr. Jonas said the devil is in the details in understanding where the SWAG can provide value.

Dr. Dickinson said that one way to go might be to have a subgroup work with herself, Dr. Meehan and Mr. Murtagh to outline options for the next meeting. She said that she is sure the next SWAG meeting will have some PRA and user survey components that need to be discussed as well. Dr. Dickinson also suggested that the next meeting should occur in person in Washington, D.C., assuming it is financially feasible and there are no major COVID-19 spikes, with a hybrid option available to those who are unable to travel.

Dr. Gombosi asked if it is known how much the Federal Government is spending on space weather research and activities. He said it is nice to have documents, but what are we actually doing? Dr. Meehan said that one would have to look at the budgets of NSF, NASA, and NOAA's research arms for the space weather community in order to compute that total. Dr. Dickinson indicated that some of those numbers are hard to find in the budget documents. In some cases, they are not called out specifically, or the numbers are parts of other programs. Mr. Murtagh recalled seeing a recent Government Accountability Office (GAO) report on space weather that may contain some of these numbers. Dr. Gombosi remarked that the statutory and policy frameworks contain a lot of words, but it would be very useful to know how much is actually behind the words. Dr. Jonas suggested checking if OMB would be willing to prepare a specific crosscut for space weather. He also suggested narrowing down the priority objectives.

Dr. Duncan said that one of the common themes that gets brought up across the space weather enterprise is the concept that there are a lot of guiding documents, reports generated, groups, and voices. She questioned to what extent part of the ask is to provide some feedback on how to prioritize those different inputs. Dr. Meehan said that could be something for the SWAG to decide going forward.

Mr. Murtagh emphasized that prioritization is always tricky. The main priority of the SWORM's activity is building resilience to space weather. If there is a particular vulnerability to the electric power grid, and the consequence to the nation is a blackout over a large part of the country, there is no greater concern than that. Such an event would establish a priority over everything else, as it would automatically bring in continuity of government and national security interests.

Dr. McIntosh stressed the importance of consolidation and coordination in light of the lengthy list of activities the SWAG is tasked with. He said he is wondering if it would be worthwhile to have a roundtable with the SWAG and the relevant government agencies to talk about the priorities for the next four or five years in the domain of space weather. He suggested they could also present the amount of money that the Federal Government is spending at that event. He also added that the space weather community needs to think more strategically in the execution and development of mission concepts.

Dr. Spann commented that the SWAG is here to respond, advise and provide input to the SWORM. With regard to the decadal and other priorities, the agencies respond to those kinds of community inputs depending on their policies or laws. NASA has to respond to the decadal survey; Dr. Spann said he is not sure if NOAA or NSF are required to participate as well. He said he would love to sit and strategize together, whether that be at the SWORM or through a space weather summit of sorts.

Dr. Dickinson asked if any SWAG members are particularly interested in engaging on the topic of processes by which the SWAG might arrive at some recommendations to give the SWORM. Dr. McIntosh, Dr. Duncan, Dr. Tobiska, Dr. Ho, Dr. Elliott, and Dr. Bishop volunteered to participate in that brainstorming effort.

Dr. Meehan reemphasized that she would like the next meeting to occur in person, ideally in Washington, D.C., in late September 2022.

1:55-2:00: Closing Remarks (Dr. Tamara Dickinson, SWAG Chair)

Dr. Dickinson thanked everyone for their attendance. Dr. Meehan adjourned the meeting at 1:56 p.m.