Session 2: Space Weather Impacts and Mitigation

Speakers

- **Ms. Kenyetta Blunt**, Chief, Recovery Planning Branch, Federal Emergency Management Agency
- **Mr. Ralph Stoffler**, Director of Weather, Deputy Chief of Staff for Operations, Headquarters, US Air Force
- **Dr. Ken Friedman**, Senior Policy Advisor in the Office of Electricity Delivery and Energy Reliability, Department of Energy
- **Mr. Mark MacAlester**, Telecommunications Specialist and National Response Coordinator in the Disaster Emergency Communications Division at FEMA
- Moderator: **Mr. Jack Anderson**, Department of Homeland Security

Jack Anderson: Can everyone hear me? Good. We're going to get going with session 2 on space weather impacts and mitigation. I'm Jack Anderson. I'm with the Office of Infrastructure Protection at the Department of Homeland Security. I'll be moderating the panel and introducing the panel and subject matter experts that we have speaking today.

Each of the folks on the panel have a chance to talk. You'll get to hear a variety of interagency perspectives on how the federal government is working with our partners to manage space weather impacts and some of the works that's going on across a number of different agencies in a number of different areas.

You heard this morning some of the challenges, both in terms of data associated with space weather, and in terms of how we drive and inform an improved approach to how we're managing space weather risks.

One of the challenges in Homeland Security, in particular, but really in domestic operations in general is that we do have an all-threats mission. That means that we have to manage everything from asteroid strikes to active shooters.

In a resource-constrained environment, that presents particular challenges, especially when we're looking at a hazard like space weather, which exists right at the confluence of natural risk and technological risk. That creates some particular challenges, and you'll get to hear a bit about how we're managing that across the federal agencies today.

I'll briefly introduce the panel members. As I said, each of them will have a chance to talk to you about things going on in their particular area of expertise, and we'll have time at the end for questions. I'll remind you again after the session, but we'll have folks line up for questions at the microphones, hopefully have a robust discussion at the end, as well.

Kenyetta Blunt is the chief of the Recovery Planning Branch at the Federal Emergency Management Agency. She'll be talking a bit about the Power Outage Incident Annex to the National Response

Framework and the National Disaster Recovery Framework that's currently in the works. We'll get an update on some of the status of that, as well.

Ralph Stoffler, you know. He's already spoken with you this morning. He's the director of Weather and the deputy chief of staff for Operations at US Air Force Headquarters here in Washington, DC.

Dr. Ken Friedman at the Department of Energy is the senior policy adviser at the Office of Electricity Delivery and Energy Reliability.

Mark MacAlester is a telecom specialist and a general disaster communications expert at FEMA and the national response coordinator in the Disaster Emergency Communications Division.

A very interesting and broad spectrum of perspectives from across a number of different areas of operation and areas that are impacted by space weather. Looking forward both to their presentations and to your questions at the end.

Kenyetta, you're up first.

Kenyetta Blunt: Thank you. FEMA is actually in the process of doing two things. The first one I have slides, the second one I'll just go ahead and talk to. We're still in the process of doing some negotiations. I didn't feel it was appropriate to go ahead and put slides up for it to change.

The first thing that we have currently started doing that significantly impacts space weather is we have gone ahead and started developing what is the Power Outage Incident Annex. This is an All-Hazard Approach as Jack had mentioned.

This was something that we were looking at prior to the whole space weathers. A lot of these became quite evident to us following the outages that we've experienced in Superstorm Sandy as well as Hurricane Katrina.

We also had a series of different exercises such as Cascadia Rising and the New Madrid Seismic Zone exercise as well as space weather that really help us to demonstrate the current plan and process that we had in place to go ahead and address a long-term power outage was insufficient at best.

As a result, FEMA and DOE decided and go ahead and co-lead the development of a Power Outage Incident Annex that is addressing both response and recovery for the federal interagency operations plans.

For those that are not familiar with the emergency management, that's basically how the federal government is going to operate in some type of a significant event. We were met with some challenges. I'll go through and explain a little bit more as we further go through.

One of the biggest challenges that we ran is what we discovered, believe it or not, is the federal government actually does not own power lines, it does not own power companies. We do not have power restores. We do not have the linesmen. We don't do any of that.

What we do is we do have resources and capabilities to be able to assist. There were also some other limitations that were preventing us from being able to rush out there. As much as we try, we realized that I couldn't get Jack or anybody else to go out and lay lines, and for them to actually stay out. It didn't work too well.

We had to really go through and take a look at what it is that we could and couldn't do to come up with ways of how the federal government could assist in the power outage of long-term significance but also not develop something that would be implemented or turned on every single time…you know PEPCo turned the power out for five minutes.

Also, for those people who were not familiar, a lot of the work that FEMA does, we are in support of local, state, tribal, church, and insular governments. We don't necessarily run out and do it. We wait for them to ask us. There was also the consideration that we have to wait to be asked to be able to provide this assistance. We can't just immediately go out and act.

Because power and energy is such a...Power outages happen so frequently throughout the United States. We didn't want just immediately be going out and trying to implement this power outage.

What we did was we came up in consultation with Department of Energy, working very closely to figure out what would be the parameters that we would be utilizing in order for us to implement this Power Outage Incident Annex.

It was when it became significant enough that power companies felt that the restoration time or that it was significant enough of it that they would go ahead and request additional assistance from the federal government, and it would primarily be for the purposes of assisting with life-saving, life-sustaining actions that would help to assist those people who were impacted as a result with the power outage.

As you can see, what we did when we were developing this was we were taking a look at...We were thinking long-term, we were thinking big cities. This could either be a small region, a state, it could be the nation, we don't know.

We thought big when we were developing this plan. We looked at multi-region, multi-state, millions of people, for long-term power, just something for more than a week.

As we were in the process of going through and developing this, we realized that even though we've had pockets like in Hurricane Katrina where there were areas where people had lost power for a significant amount of time, most of the population relocated.

We really worked dealing with large populations of people who were impacted for long periods of time. [clears throat] Excuse me. In this case, if you had, say for instance the whole entire east coast that was impacted by a large power outage, it would be a little bit more difficult for people to very easily up and relocate.

Getting people to think beyond just the normal week or two weeks that you would see with the a hurricane, or even a bad storm was quite challenging, and what we found is that there was a lot of agencies and organizations that really were not capable of being able to do that.

Through this, we've got a lot of our agency partners go ahead and start thinking beyond just their normal restoration of all hazard type of things. Normally, people think of bringing in a generator, or they would think about maybe relocating or setting up a mass care shelter, but if you have millions of people, and you can't necessarily relocate them, that became a challenge.

In this process, we were able to get through and challenge a lot of our inter-agency partners to start thinking beyond that. The big thing that we also realized is in the development of this power outage incident annex is that this is not a restoration plan.

As I mentioned, we realized that the federal government does not restore power. What we do do is we can go ahead and provide assistance to a lot of the states and locals to be able to assist them in being able to take care of populations that are significantly impacted.

We were looking more at what would be the mass care type services or how we would be able to go through and assist to prevent loss of life, minimize some of the additional impacts to those populations that were suffering through as a result of the power loss for a long-term duration.

We were also looking to try to look beyond just what would be some of the major impacts as a result of the power that would be on two weeks, and what we found was there were a lot of cascading impacts.

A perfect example would be a lot of states, locals, even your hospitals and stuff, they're able to go ahead and sustain for a power outage of a week or two, as long as they have the ability to be able to refill their generators. They could keep the water systems going, they could go ahead and take care of their hospitals, they could go ahead and cut back on critical stuff, but if they are not able to actually bring in the transportation to go ahead to refill the generator so there's not enough generators. All of a sudden those plans that a lot of these organizations had in place don't work.

That's what we were expecting or what we are expecting to be able to have a large some type of a space weather event that would necessary, that would potentially impact large portions of the grid.

You would not necessarily be able to go through and just rely on necessarily generators and being able to come back and bring in fuel as we normally would for New Orleans hurricane or something that happened in South Florida.

It's too large a population, is too great so we really would have to be looking at something completely different to be able to address those people who have been impacted.

We are hoping in the development of this power outage incident annex that we're actually able to go ahead and start addressing some of those large problems that we had faced in small populations. We never really thought beyond just what would happen if it was a population of 2,000 people. 2,000's easy, we have generators. 200 million is significantly different.

What we've done is we've gone through and we've kind of looked at a number of different...we've gone ahead and beyond and expanded further beyond. We took a look at what would be some of our crisis actions planning, how we'd be able to address some of the [inaudible/indecipherable], how we'd be able to work with a lot of our power companies as I mentioned.

A lot of the power companies, it's their job and their responsibility to go ahead and to bring the power up, we don't. What we can do is, we also realized we could go ahead and start partnering with our sector partners and the energy companies in the energy industry to go ahead and start working closely together.

Looking at trying to reinforce closed road closures and public safety so we can ensure that they have access to be able to start addressing those things that they need. Working and coordinating on things like debris removal so we can go ahead and make sure that the companies can go ahead and work on...they can get access to the areas that are most impacted.

We've also gone through, and I'm going to have to go through really quickly, a number of different catastrophic outage considerations that we went had added on here to make sure that this would be

able to truly address something that was beyond first 72 hours and kind of really going into things that would be more impactful to the population.

What we can go ahead and do is provide these slides for people and I do apologize for going through these very quickly.

In summary, on the power outage and [inaudible/indecipherable], what we are trying to do or what we've attempted to do is, to try to go through and start addressing how the federal government would be able to assist a lot of the power industries to be able to handle.

To assist them with restoration and make access easier for them to be able to go in and do what they need to do while we're still going ahead and addressing the population and those people who have been significantly affected by power.

The other thing that FEMA is working on is a space weather comm plan. This is something that was requested of us to go ahead and do in an executive order.

What we're doing is, we're actually in the process of developing a comm plan that would go through and address how each one of the agencies would go through and in possibly a space weather event.

What would be the actions that the agencies would be doing in order to prepare for and then how they would respond back to an entity which we're still trying to negotiate who that entity is. The actions that they have taken to prepare for and then restore from some type of a space weather event. We are trying to figure out exactly where the most appropriate places for this.

We're back and forth negotiations with the number of different folks trying to figure out who actually would be the collector of this information because we're realizing in this particular plan, we're not necessarily dealing with our Emergency Management community which we could very easily reach out to and there's a mechanism in place but we're actually looking at the whole of government.

We're looking at organizations and agencies we don't necessarily deal with such as the IRS or Department of Education. They're not as familiar with some of the things that we would be doing in the Emergency Management community.

We're trying to bring them in to have a more realistic whole plan on how the federal government or how that information is collected and then provided back to in the event of some type of a space weather event.

Also as part of that, making sure that those organizations or agencies that have partners within the private sector would be able to reach out to them such as some of the electric industries informing them that there's a potential for some type of event, finding out what it is that they're doing and then being able to provide that information back so that we are having both preparatory actions taking place and then post actions.

As I mentioned, this is something that we're still in the process of kind of working through, trying to negotiate, trying to figure out who does what, what are the responsibilities and trying to identify who exactly would be the collector of that information.

We're hoping to be able to have this completed within the next week or two but we are still back and forth trying to develop that. You will be seeing something on that space weather comm plan hopefully soon. Thank you.

[applause]

Ralph Stoffler: OK. Are you ready? We have to use a different display mechanism. As you can see, DOD's different, different cyber-security roles, different computers, different, different.

Let's get started. Next slide, please. All right. Let me cover real quick on what we're going to talk about. Obviously, you've already heard the DOD focus area. We are focused on a very specific mission sets not so much of the research piece but solving problems which impact our day-to-day operations. Next slide, please.

The message here is that the DOD operates in the entire spectrum. We're a global mission set and we operate satellites from the top. We have ships at sea. We have ground forces deployed and sometimes we focus of a very large area. Sometimes you're only talking about a very small area with a very small team.

We have niche products for those mission areas that cover the entire globe and it's a very difficult challenge. Next slide, please.

Why is this important? You heard some of those comments earlier today. When you're flying a bomber at a high level, that's at the standalone mode, you need to have long-range communications. You need to be able to communicate, you need to have your GPS work, you've got to be able to find your target, hit your target and only hit your target.

When you're doing air-to-air operations, the same issues taking place, you have multiple airplanes out there, striking multiple targets, being command and control that by another airplane and again the HF communications needs to be perfect and the GPS needs to be right on line.

The other thing which is very big for the DoD is information intelligence collections. We're increasingly doing that remotely via remotely piloted aircraft which means long all communications depends on satellites are very very important. For those airplanes that we still fly at extremely high altitude, it's obviously critical at this point in time to see what the radiation impacts are on our air crews in particular over the Northern Tier areas. Those issues way on us critically in every operation that we do. Next slide.

Characterization of the environment is very important. We track lots of satellites. We track orbit debris. We worry about enemy missile strikes. We worry about satellites dropping in orbit.

All those things are watched on a 24/7 basis. Again, space weather is very, very important in those areas. We try to control things on the ground.

As you probably heard in the newspapers plenty of times, anytime civilian casualties take place, it's a big deal. We try to minimize that by providing very accurate strikes, hitting the target, and avoiding civilian casualties. GPS and satellite communications are very critical to make that happen.

Even if you're on the ground and you're an infantry guy supporting the United States Army, your handheld GPS device is important. You need to know where you're at. You also need to know where our airplanes are at because you don't want to be where they're going to bomb the target area.

If you're out in the desert in the middle of nowhere or in the central part of Africa, GPS is really the way of doing business. That's why those single GPS frequency devices are still very important to us in the ground campaign. Next slide.

Now what do we do from an observing perspective, and how do we this business? Obviously, we're focused on operations, which means, as we build sensors, we try to build sensors which sense information that directly links to the operation needs we have.

We don't necessarily like to build things that go beyond that. We try to keep costs down. Sometimes the sensors we build are focused on the ops piece, but not necessarily on the research piece.

The other thing which is very, very important from a DOD perspective, and we've learned that probably literally over the last five years or so, is we've relied a lot on non-DOD sources information, educational capabilities, academia, international sites, and so forth. Where all too often, when you go into a combat environment, those sensors and data may not be there.

Assured availability, dedicated communications, and the need for the data to be there when we need it most is very, very important to us. The last part, I'm sure all of you know. We deal with cyber security everyday.

As there are increased cyber security incidents, cyber acts, we need to make sure that our networks and our sensors are cyber secure, compliant so they're there. The best sensor in the world doesn't do you any good if you can't get the data back and process it. That's a big priority for us. Next slide.

Here's the classic example on how we do business from a sensor collection point of view. It's almost reverse engineering. What mission do you accomplish? What are the sensitivities that particular mission has? What products do we need to support those sensitivities? Then what sensor, what data do we need to collect to build the products to mitigate that particular operation?

That linkage exists for each and every one of our systems. You'll find that our sensors are there for a very specific purpose. It's not just collecting data or collecting all data, but collecting specific data types to support that mission center.

You heard that this morning, too, which I want to highlight Dr. Volz's speech. There's more and more data out there. The amount of money that we're spending to process data is increasing all the time.

We really need to decide, "Do we need all this data? What's the purpose of this data? How does it help us?" Simply collecting all the data that's always available, we need to make a mindset transition in that because you can't do it anymore.

That's one of the things that we're doing. Collect the right data for the right mission, have it available at the right time. Next slide.

The applications, in the 557th Weather Wing, we operate a Space Weather Forecast Center, the Space Block. They are there 24/7. We have a liaison with our NOAA operatives down in Boulder. We work close at hand with SWPC. We are there to the DOD unique piece.

We also interface with key other military centers across the globe. It's a very good system, and it allows us to focus on getting the operational decisions done.

Now the way we do it is the guys at the 557th do the space weather piece. The actual impacts and how the operator is going to react happens at the JSpOC out at Vandenberg.

We basically relay the information out to Vandenberg. Vandenberg looks at the operational mission set, and then makes a decision on what to do next. I.e., if there's a satellite having problems, "Is there a space weather problem?" If there is not, then perhaps the satellite is experiencing some sort of technical difficulties.

That relationship is there. They both work 24/7. We're expanding that operation from the JSpOC into the JICSpOC to cover over customers as well.

We do that not just on the unclassified side by also on the classified side, which is a big issue for us. We support basically all the classified players across the US government and international agencies. Next slide.

You already heard me say this morning we can't do it alone. Integration and cooperation with everybody out there is where we need to be. We have a training course. We teach applications.

We brought in international partners from France, Italy, Germany, and the Netherlands. We've got an excellent relationship with South Korea and the Japanese. International cooperation is a very, very big thing for us.

Working close in hand with the civilian agencies is also where it's at. We've already got a liaison with SWPC. We just established our liaison with the UK Met Service. We're now in the UK, and we're talking about expanding liaisons with Korea, Germany, and several other countries.

Of course, leveraging what everybody does is important. The days of trying to do everything yourself is definitely gone. We're actively pursuing buying commercial data, leveraging commercial capabilities.

We're working with NASA, and seeing what they're doing. Of course, we're also working with whatever academia brings to the table. For example, Utah did a great job for us in building our full physics GAIM capabilities.

Leveraging everything on the table is definitely where we're at, and it's providing excellence. Next slide.

Policy is a big deal. A lot of us look at policy and say, "Well, that's words." Words matter, in particular from a governmental perspective. As budgets become tight, policy is very key.

If you have public law and OST policy that tells you to do things, that's an important aspect. We're helping develop policy both on the classified and unclassified side of the house. That's a great way to go.

We've established contacts with the White House now where we have a 24/7 space weather capability support via a presidential operation. We recently stood up a presidential weather support unit.

They were focused primarily on traditional weather. We're incorporating space weather in that as well. The Administration is being advised of space weather impacts and has meetings on what they do.

Of course, we're also part of the executive order, just as you heard, DOD doing its part and prepare to assist other agencies as required. Primarily, we focus on the OCONUS missions. If asked, we're ready to help here with CONUS as well.

That's an important thing. Certainly from the emergency perspective, this goes right to our job and general costs. Next slide.

In summary, we're committed to this. This is important. We live the space weather drill each and every day. What you heard this morning is that people die because space weather has impacted our communications capabilities.

We need to anticipate that and prepare for it. We've become very, very good at telling our aviators and ground forces, "There's a haboob. There's a hurricane. There's severe thunderstorms. There's turbulence." All that is incorporated in, and they've understood it. They know how to mitigate it and plan accordingly.

We need to reach the same level with space weather because the impacts are out there. It's a lot more subtle. People don't see it, but it impacts our systems. This forum will be a great way to improve that kind of cooperation.

Thank you very much.

[applause]

Ken Friedman: Thank you very much. First, I should say I'm not the space weather person. It's John Ostrich. If you call 202-586-5000, you get his phone number. I'm going to stay on this first slide because you're going to get all the slides.

What I want to talk about is more practical. Transformers are key elements in terms of the potential threat from a GMD or an EMP event. Both of them could have a considerable impact.

We need NASA. We need NOAA. We love them. We want them to continue in effect advising us, warning the industry as to when something is happening. The more discreet the information that they can share, the better.

The FAST Act was passed by the Congress in 2015. We completed a report in 2016, but it was published in 2017. It is on the Internet.

Basically, what it said was that we would like to wait. We hope we can wait for several private sector initiatives that are underway now, including Grid Assurance that's led by AEP and other utilities as well as Restore, which is led by the Southern Company. Then you have Wattstock which is also working to deal with threats to the potentially nuclear side of things.

The DOE report, which came out, was focused on, "Do we need a strategic transformer reserve?" We didn't answer that question. We, in effect, suggested that we wait till at least the end of the year to see what progress is being made by the utilities in terms of organizing themselves.

They are working on private sharing arrangements that would reduce the costs to any individual utility. They are focused very much on sparing, not only spares for transformers, but spares for other needed parts of the grid that could be impacted by space weather or other types of situations.

In terms of spares, what we learned from the FAST Act report was there are really quite a few more than we had known, but is it enough? Then it gets back to the question of, "What's the scenario?" Nobody agrees on the real scenario.

We have various degrees of scenario that can really have a major impact over long periods of time on population centers. We also are working, talking, and trying to talk up the whole issue with manufacturers as are the utilities.

They've been working on basically increasing the resilience of their transformers. They're using new insulating material, in some cases. One of them is NOMEX, which is produced by DuPont, that can raise the potential heat that the transformer can in effect work through.

We also have, as you're probably aware, we have a number of new greenfield plants that have been built in the United States. They're all in the process of increasing their staff so that their capacity is greater.

We're handicapped by the fact that the growth rate in electricity is very small. Because of that and because the nuclear is not quite turned out the way some had hoped, the demand for the large transformers is not overwhelming at present.

All of the manufacturers are working on various initiatives, including lightweight, in reducing the weight, in effect, creating transformers that are separable so they can be moved in different pieces as opposed to a single piece.

They're all worrying about, in particular, the transportation of the transformers, which is a really serious question because of their weight, because of barriers at the state level, particularly in the movements of these transformers, the availability of the large units to move them over rail or, for that matter, over the roadway.

The last mile or two is also an issue and they have real serious questions as to whether there's an adequate workforce nationally. If we had a really bad day, as DHS likes to tell us, and FEMA likes to talk about too, can we do all of this all at once?

Part of what we're doing now with Phase II of the FAST Act analysis, in cooperation with Oakridge National Laboratory, is we're working with a number of utilities including Dominion, AEP, Duke, TVA, Southern Company, and even CenterPoint, which is the one utility that has been very much focused on EMP in terms of, what would you do if one of your major population centers in your service area was severely impacted to take out multiple substations and multiple transformers?

They're all working on that issue right now and we hope, by the fall, to have reports from a number of these utilities as to how they would go about doing it. Some of you may be aware that some utilities, including Dominion and Con Ed, have moved ahead. There's certainly have been additional spares purchased.

They're also concerned that the spares shouldn't necessarily be at the substation and they're worrying about and working on how they would transport the spares from one place to another. You also have mobile transformers that are also of an issue and the companies are looking at how they might get more of those and house them in someplace that they could be brought to bear in a situation.

We hope to work closely with DOD and with Commerce, relative to the supply chain issues because there are some supply chain issues. Most of the large transformers are still coming from abroad. Some of them come from parts of the world where they're not completely safe and have other threats that exist, so we're trying to work with them.

In addition to that, we have FERC and FERC had SIP 14 and the second part of the SIP 14 asked utilities to identify their most vulnerable substations or their most critical. That may not be the word they want to use but their most important substations, which they're doing.

In part II of SIP 14, they're supposed to plan to replace what is needed in those substations. In an emergency, what would they do? We're very optimistic. We've tried to stay away from specific scenarios.

We know that there are multiple approaches to attack, including simply 50 caliber rifles. Any of those can do significant damage to the grid and we also know that the manufacturers are working on, basically, protecting those units from that sort of possible attack.

We had the Metcalf incident that occurred, which was a more sophisticated and we hope it's not replicated again because they not only attacked transformers, they attacked the communications highs between the substations and the company that was going to be impacted.

We're hopeful that working with these utilities that we're now working with, that they will take their findings and I'm sure that we will be able to share those with other utilities as to all of the individual steps that need to be taken for restoration and recovery. We're not a major party.

I notice we only have two recommendations in the report that came out and some, I think it's Commerce and DOD and DHS had many, many more, but we will continue to work to augment what they do with the kind of partnership that we've been building over time with the utility industry.

We have a sector coordinating council for the electricity subsector that has approximately 30 CEOs on it. That occurred after, basically, DOE and DHS met with utility executives and from the cyber standpoint, it explained to them what the potential for interference might be and they woke up. They're very conscious of this.

This transportation working group that's led by EEI and the other trade groups in the utility industry, talking about the transportation challenges, has 70 industry executives on that group.

Last year, they were meeting with the class I railroads, which they've done, to, basically, develop plans and get commitment, that in the event of a really serious problem, they would help and that they would work collaboratively with the industry to get things where they needed to go.

This year, they're going to be focused more on states because there are barriers at the state level. There are lots of challenges. We can't take one of these things over a bridge that's collapsing or they can't handle the weight and even some of the roadways can't handle the weight of the large transformers. They have to remove the roadway and put in gravel to move the transformer.

They're also worrying about the crews to put the transformers in operation. Again, they're moving forward on it. Are we there? No. We hope to work with FEMA on this question. We've been working with FEMA for a long time in terms of potential use of the Defense Production Act. But, in the event of a real emergency, the Defense Production Act might be of some help but not quickly.

We, also, have been talking with the Canadians, who are our closest ally and partner about their sharing their resources. Again, the utility industry has a very long history of sharing at the co-ops and the muni's and at the private sector owned companies, they're used to sharing because of challenges like hurricanes, tornadoes, etc., and it's well developed. Thank you very much.

Mark MacAlester: Like the Air Force colleagues, I represent the operations community, so this is from the operations perspective, particularly in response. As NOAA and NASA like to compare space weather to hurricanes, what I want to do is use that hurricane analogy to talk about where we are on the response side in space weather.

Back in 1900, before there were observation satellites, before there were computer models, even before there were computers, before there was ever ship-to-shore radio, the way they tracked hurricanes was with fixed weather stations connected by telegraph.

In August of 1900, the weather stations started reporting on a hurricane that was moving through the Caribbean over Cuba and over Key West. Then, as that hurricane moved into the Gulf of Mexico, for all intents and purposes, it disappeared.

I'd like folks to think about this for a minute because we're so used to having information about what's going on and being able to use that information to plan, but in this instance, they had no way to observe that hurricane once it got over the Gulf of Mexico. There was no ship-to-shore radio. There were no oil platforms.

For 24 hours, all they knew was it was going to impact somewhere in the United States along the Gulf Coast. When it did impact, it impacted an area they didn't expect. It resulted in, what is still, to this day, the worst natural disaster in US history.

When we talk about what they didn't know, they didn't know where it was going to impact. They didn't know when it was going to impact at that location. They didn't know how bad it was going to be and they didn't know how long it was going to be bad. Right now, in space weather, when we talk impact, this is exactly where we are.

The first thing I want to talk about is what space weather is not. There is a lot of talk, especially, in this town about natural EMP and they refer to space weather in that respect. But, electromagnetic pulse from a nuclear weapon is very different from what space weather does.

Electromagnetic pulse has a high-frequency component, an E1 component, and that part of an EMP pulse will damage electronics like this but space weather does not have this E1 component. It's important for folks in the operations community to understand that your equipment, for the most part, will still work.

We're familiar with the three types of space weather that we care about. You've all seen these. From a response perspective, let's talk timelines real quick. Radio blackout events. You'll often hear scientists talk about how it takes eight minutes at the speed of light for this stuff to get from the Sun to the Earth. I don't like that description because, from an operator's perspective, there is no warning.

At the same time you see the flare, the energy is arriving at the Earth and doing impact. Solar radiation storms, these are high energy particles. In an extreme event, these can arrive at the Earth in approximately 20 minutes and build over a period of a few hours to an extreme level.

Geomagnetic storms, and again, we're talking extreme events, can arrive in as little as 15 hours up to about 24 hours, for extreme events. As you've already heard in another presentation, ACE and DSCOVR, those are our early warning buoys, those are critical on the operations side to knowing, is it going to be a bad day or not?

Let's talk real quick about communications impacts. When it comes to radio blackout events, you've already heard descriptions of the HF impact. What I'd like to point out to operators is that a radio blackout event does not mean all radio will be blacked out. Most radios, especially the terrestrial line-of-sight radio, is going to work just fine.

There are solar radio burst impacts that could occur at sunrise or sunset for about 20 minutes but other than that, all your communications, other than HF communications as far as voice and data, should still work.

There is a possibility that you'll have some disruption to satellite comms because there can be microwave energies that come with that radio blackout event that will impact the satellites but you're talking seconds to minutes to, maybe, up to an hour of impact. Again, as you heard from the Airforce presenters, there are contingencies and mitigations that can work around those temporary losses.

Solar radiation storm. The biggest impact here is from the potential impact on satellite operations. This particular statistic, 10 to 15 percent of the satellite fleet is an old statistic. I hear that the newer satellites are more resilient. I hope that's true.

But, what we're looking at is approximately 10 to 15 percent of the satellites being impacted on a temporary basis for most of them but it is possible there could be permanent loss of satellites. It has happened before. It will happen again. For solar radiation storms, you will also get HF impact around the poles. This is big for the aircraft industry.

Before we get into geomagnetic storms, understanding the timeline of a geomagnetic storm. You have 15 to 24 hours after this coronal mass ejection launches off of the Sun. What I like to point out, from the media perspective, is that the press gets the same warnings and alerts that we do in government. For approximately 15 to 24 hours, the media is going to be reporting on what's coming.

But, from a government perspective, we're not going to know is it going to be a bad day or not? We're not going to know until that CME gets to the ACE and DSCOVR spacecraft and we can learn its magnetic orientation.

I'm a simple guy. I'm an operator. Why does magnetic orientation matter? From when we were playing with magnets as kids, you know if you bring two of the same pole together that they're going to repel. It, actually, works the same way in an Earth/Sun system, believe it or not. If you bring the opposite poles together, they attract.

This is exactly what happens with a coronal mass ejection. It will couple with the Earth's magnetic field and all that energy will then pour into the Earth's system. For a geomagnetic storm, HF radio may actually work for the first couple of hours of a major geomagnetic storm before it begins to degrade for about one to three days.

The biggest thing that we worry about here, from a communications perspective, is that the L-band, which is a satellite communications band, will be severely impacted in this kind of event. L-band is critical. Anybody who's used a satellite phone has probably been using an L-band device. If you have GPS receivers, GPS receivers operate in the L-band.

L-band is the most susceptible of the satellite frequencies. As you get higher into the satellite frequencies, C, X, and K-bands, the effects become less. How much less? We really don't know but we're

hoping to learn that as the research continues. The other thing is you'll have timing impacts. If you lose access to GPS, you're not just going to have location impact, you're going to have timing impacts.

For the telecommunications industry, that's important because things like cell towers, if they lose access to the GPS network for timing, then they'll fall back on oscillators that they have built into that cell tower to keep their timing in sync with the network. But, those oscillators only work for about two hours.

If you have comms impacts for longer than that time, then you're going to run into a situation where that cell tower will actually, from a timing perspective, be cut off from the network. You'd still be able to make a call as long as you stay within the coverage area of that cell tower but if you tried to move between cell towers, then they would not be able to hand off the call to the next cell tower.

You also notice that we start talking about power impacts. This is the biggest question of space weather. Is there going to be a major power impact or not? Telecommunications, like every other critical infrastructure sector, depends on power. If the power is there, this is going to be inconvenient but it's not going to be catastrophic.

If the power goes away, then you start running into a lot of impacts. Anything that doesn't have backup power -- batteries, generators, whatever -- if the power goes out, you're going to lose access to those comms right away.

The problem is, as we've been doing the work to support the National Space Weather Action Plan, we've been deep diving into the impacts and one of the things we're learning is that it's a lot more complicated. The intensity and the magnetic variations change throughout the storm.

This is what it looks like in a practical sense. This is an article from 1921, the last extreme event that impacted the Earth. You'll see from the article that they talk about, sometimes stuff worked normally and then other times it would do the "puzzling dance." I love that. They also talked about how neighboring systems, one would not be impacted and another one would be.

The other aspect of the extreme events is that they bring friends. They don't generally happen by themselves. In 1921, the biggest storm of that was actually the third storm in the sequence of a large sequence of storms. The Carrington event, very famous, was actually the second extreme event that occurred. The first one occurring about four days earlier.

Then, the Halloween storms in 2003, one of the reasons why we didn't learn about space weather in 2003, is that the biggest event there didn't have a southward magnetic orientation. But, it was a series of 17 major flares.

When we talk about power impact to critical infrastructure, this is probably true across a lot of the critically infrastructure sectors, 8 to 24 hours is about planning for batteries and small generators.

For those of you who saw the coverage of the Honshu earthquake in Japan, you would have noticed that for about the first eight hours, there was a lot of, "I am here reporting on CNN, FOX News, and MSNBC." Then, after about eight hours, that reporting stopped. Why? Because people's batteries had run out and they had no way to charge them.

If we go to three days, three days is about a medium planning factor, medium sized generators and facilities, it's a planning factor that is commonly used. As you start losing more infrastructure, the impacts start to become greater and greater across the entire infrastructure space.

If you get to seven days, seven days is a common planning factor for large generation and large facilities. Many emergency operation centers use seven days as a planning factor.

What we've discovered, being in FEMA, is that seven days is actually about what people can do without a whole lot of extra help. Communities are very resilient, for the most part, up to about seven days. After seven days is when it starts to get challenging.

Within the space weather community, one of the things that we need to really focus on is that it is a partnership. At FEMA, we could not have done what we've been doing without the help of NOAA and NASA. It's been absolutely critical, our partnerships with the Department of Energy.

It's not just a one-way relationship. It's not just the researchers saying, this is what we can tell you. It's us saying to the researchers, this is what we need because a lot of times, the researchers don't understand what, from an operational perspective, we actually need to see. The same is true with the engineers.

We need a close working relationship with engineers to be able to share the kind of information that's valuable to the end-user community. From a preparedness mitigation perspective, one of the good things about space weather is that it's a natural hazard like a lot of other natural hazards.

That means that the things that you do to prepare for hurricanes, tornadoes, earthquakes, and volcanoes are the same things you would be doing to prepare for space weather. A lot of this preparation is described both in the ready.gov site, for individuals, it will tell you what supplies you need to keep in your home. It'll talk about family communication plans and stuff like that.

This also works when you start getting into commercial and government organizations. Things like having backup power. Kenyetta talked about the fact that a lot of folks will contract with fuel contractors for their generators.

What they won't realize is that, that same contractor has contracted that same capability out to a lot of different organizations. The assumption being that not everybody's going to ask for it at the same time. When it comes to planning perspective, especially for a potential for long-term power outage, you really have to understand what is behind that contract.

Make sure you have multiple means of communications, know what systems will work and when they will work throughout a storm, and stay informed. Coming to events like this and talking with our partners is critical. Thank you.

[applause]

Facilitator: Thanks, Mark, and thanks to the rest of the panelists.

[applause]

Jack Anderson: Thanks, Mark. Thanks for the rest of the panelists. We're actually a little bit of ahead of schedule. If you have questions, please head to the nearest microphone and form an orderly line.

While folks are doing that, I thought I would ask a couple of questions of the panelists, notes I was taking as they were talking. Mark, I'll ask you, and maybe it's also a question for Ralph as well.

I heard you make you this point before about the science engineering-emergency management connection point, and then how it's important to strengthen that. Do you feel like there are particular gaps in that relationship that we need to address?

The DOD connection, I guess being what Ralph talked about, is a pretty robust connection between the sensor to operator connection that you folks have to make in the Air Force. Are there things that Homeland Security community needs to learn from the DOD community on this? Are there particular gaps in your world, Mark, on understanding the comms piece I guess?

Marc MacAlester: I guess this is a good news story is that we've actually got very good partnerships. NOAA, especially the Space Weather Prediction Center, they've been partners with us for years. They are absolutely fantastic in sharing information, educating us, because I'm an operator. Kenyetta's a planner. Space weather is not what we do for a living.

It's a collateral duty thing. Being able to link with experts in the research community and have them educate us about what it is that we need to care about has been really important, but there's another aspect to that. Just as much as the researchers are teaching me and engineers teach me about what space weather is and how it impacts systems, when we talk to them, we're teaching them, "This is what we need."

Simple things, the radio blackout event, I've asked the NOAA folks, "Please change the name of that because it's confusing people in my world." They think radio blackout event means none of their radios are going to work. We have to then explain, "That's not true."

We talk about, especially with the ACE and DSCOVR spacecraft at L1, "Right now, we don't know if it's going to be a bad day or not until approximately 15 to 20 minutes before impact."

From an operator perspective, I'd like to say, "That's not good enough. We need to do better than that." In order to do better than that, there needs to be new research, new models, new observing platforms out in space.

We're telling them, "Hey, we need to know what's going on earlier," and then we leave it to them to figure out, "Is there a way to do that and how would they do that?" With the engineering community, it's a matter of the private sector.

The private sector is a little weary of government. You can't say, "Hey, I'm from the federal government. I'm here to help." That sends them running.

We have to build trusted relationships with industry. What we really need, when it comes to impacts, you can tell me that the Northeast or the Midwest is more vulnerable, but if there's an actual event about to occur, I don't know anything about the impact. I don't know where to send response assets. I don't know where to posture stuff because the area is too broad, and we have finite capability.

Our partnerships with the private sector engineers is it's like, "Hey, can you guys maybe, keeping the proprietary information closed from us, but at least give us some idea what areas are we looking at that we're likely to experience impacts?" That's the partnerships we need.

With a private sector, that's probably the biggest gap we have now is being able to have that open dialogue with a private sector without them concerned about releasing proprietary information and the possibility of regulations and such.

Ralph Stoffler: The only thing, which I'll add to that, obviously within the department, we have a very robust mechanism to get from an operational requirement into developing the capability. We don't necessarily have this gap between research to operations.

One of the things that I have been trying to do, whether I want to or not, because it's the way the system works...What we have done on the ops side, for a long time, is we look at what's available out there. If somebody else has a good idea or has data available, we tend to grab that, incorporate it in, and start using it.

What we haven't done at DOD is plan on what happens when that data suddenly goes away. I certainly learned that lesson the hard way over the last couple of years as we deal with international satellite constellations. We use data that comes from the Europeans, or from the Japanese, or whomever.

Then, suddenly, this data disappears. Then you go into DOD and you say, "Well, I need to buy or build something because this data went away." What I came to realize is there was no requirement stated that actually said we ever needed the data.

We have a tendency in our business of jumping from here's what we want to some sort of technical solution. We skip the process in between, because it makes things easier. What I've had to do is to go out and formally state a requirement, "The operational community needs this."

You go into the process. Maybe at the end of the process, they'll come out and say, "Well, we're going to use the European data set for free. That's your answer to the problem." Now, at least, I have a mechanism in place that if that data source goes away, the department is aware that I actually need that kind of data from that part of the world.

Now they're in a position to either build something for me, or get it from another means. I think that's a very, very important piece. Certainly, in our department, we've gotten to the point where we have to justify every dollar we spend. Every dollar is linked to some sort of operational requirement.

I've spent a lot of time stating the requirements and documenting that to make sure we have continuity of operations.

Jack Anderson: Sounds good. Let's start over on my left.

Audience Participant: [inaudible/indecipherable] advocates for space weather, you're going to need to get word out about that. Then, the next thing I'm wondering about, as far as the continuity of data...There's a project I started helping the National Defense University with on a disaster blockchain. I'm wondering if anybody's thought about that public ledger aspect to posit data for space weather, as well.

The two questions are, your funding, is any of it on the line? Do we need to be worrying about it? Are any of your agencies looking at blockchain or other aspects for using or getting data for in their offices?

Ken Friedman: We don't know about the funding. I can neither confirm nor deny anything relative to funding levels. It'll have to be teased out through the process that will go probably into the fall, on the second question. On the first question, I don't know anything. Sorry.

Jack Anderson: I'll make a brief point, maybe a slightly more subtle point about funding. I think you'll hear later this afternoon some of the legislative and policy activity that's been happening related to space weather.

In particular, talking about -- and Ralph's mentioned this as well -- The National Space Weather Strategy and the actions that that's driven. Obviously, there are budget uncertainties and things like that, but I think there's clear policy interest.

Jack Anderson: On the right, here on the right, sir.

Audience Participant: This question relates to those data streams and the continuity of data. The question is mostly for Ralph, although I would've loved to have put this to Dr. Volz, as well. The DSCOVR craft, since its launch, has been experiencing some intermittent data irregularities. If you actually watch the DSCOVR solar wind, that would be the enormous plateaus that show up.

It has been conjectured that that's cosmic ray interference. We've started to see the same thing on the ACE solar wind readings, as well. Is there a legitimate concern? You mentioned LASCO and the coronagraphs being a significant need. We knew that ACE was...It's 15, close to 20 years old.

We've seen those data glitches on DSCOVR already. Is there the same level of concern over that L1 Lagrange point and the data that's coming from there? By the way, when the Japanese NICT magnetosphere models went out, that was very frustrating. Sir, I feel you on that one.

Ralph Stoffler: Certainly, we do have those concerns. It's actually a driving force in several areas.

As you know, we've got a significant amount of older terrestrial-based systems that watch the sun. One of the drivers to keeping those systems alive is that in the event the coronagraph fails and the on-orbit capabilities aren't there, we've got something on the ground to fall back on.

We're in the process of developing a modernization plan for those blends.

It puts the DOD into, let's say, the best of both worlds. On the one hand, I can leverage NOAA capabilities. In the event that NOAA loses those capabilities, I've got backup within the DOD network and team operations system.

Audience Participant: Hi, this question's for FEMA. I did not hear any preparations in the way of food. Space weather seems to be affecting all weather, or weather seems to be drowning our vegetables and killing it with hail and floods. We are getting short on food.

The entire world is seeing shortages of food, wheat crops in Kansas, grapes, apples, all kinds of vegetables and fruit. I'm wondering, do we need to start growing our food in greenhouses?

I know we are not farmers in the government. We don't lay power lines. Without food, that's a national security issue.

Kenyetta Blunt: I can say that I'm not aware of any planning so far on food. That hasn't been anything that has popped to our radar yet, but it doesn't mean that there might not actually be something that would arise later on that we're being asked to go ahead and address that later on.

Do you have anything, Mark?

Jack Anderson: The way that you described concept of support for [indecipherable] is the large part looking at how you're supporting the power restoration efforts, right? A lot of the scope in the way that the [indecipherable] defined is community support to allow power restoration to occur.

Can you talk maybe a little about what's in [indecipherable] in terms of mass care and those kinds of things?

Kenyetta Blunt: Sure. As far as mass care in the event of some type of a long-term power outage, what we've been doing is working with our mass care communities as well as the stocks that we have, too, in our state and local partners and volunteer organizations to be able to address initially what would be the needs to be able to assist folks that are in the impacted area with providing them food should there actually be some type of long-term outage.

We see these in a lot of natural disasters now where you'll see the Red Cross trucks come in or Salvation Army. They can go ahead and provide assistance, but we also had to take a look at if it was long-term.

It would be very difficult for us to continue to bring food into that area. One of the considerations that we're looking at is, "How do we go ahead and bring people out of the area into areas where able to go ahead and better service them?"

It's something that we're still continuing to work through. It's also something that a lot of our regions as they're developing more regional-based plans with their states and locals are also addressing further.

For instance, if Chicago were to lose power for three months, we wouldn't necessarily be bringing in supplies into Chicago. We may be looking at bringing the people out where the resources are to them until we're able to get restoration back into that area.

It is something that we are considering, specifically more when we're getting into our regional plans where it's more operational and where they're working closely with the states and locals to be able to address a lot of those concerns.

Audience Participant: Hi, I'm curious. How does the DOD isolate and protect classified data when you're sharing data, especially real-time data with other organizations?

Ralph Stoffler: There's two ways of doing that. If the data source itself comes from a classified location, it is treated strictly in the classified networks. We have data processing capabilities, which operate on the various security enclaves. That is generically the best way of doing business.

There are some data types, or actually a lot of data types, which are unclassified. What we do is we take the unclassified data together. We process it. Then, if we apply algorithms to that unclassified data that is classified or results in classified results, we've got one-way guard systems that push it from the unclassified side to the classified side. That's where the data's processed.

Obviously, the challenge is that, once it's up on the high side, it basically has to stay there because going back the other way is virtually an impossibility at this point in time, even though they're working. The bottom line is two separate networks.

Actually, you have the unclassified network, then you've got the secret network, top-secret networks, and classified.

Audience Participant: Hi, my name is John [inaudible/indecipherable]. Should we worry about a thousand-year event? There are currently [?] design bases like [?] tandem events, but solar flares have been observed on similar stars [inaudible/indecipherable], then super flares do occur.

I understand that, when the big dams are built, they are built to withstand a thousand-year earthquake. Obviously, I'm not certain of that, but should we worry about planning for a thousand-year event?

Jack Anderson: Do you all want to take a stab at that one?

Marc MacAlester: First, one of the things that the White House's National Space Weather Action Plan is trying to do is, one, it's trying to set a benchmark for a hundred-year storm so that, when we talk about the response environment, the preparation and mitigation environments for space weather, we're all talking about the same thing.

As part of that effort, they're also going to be looking at, "What is the maximum maximums that's possible?" There is research that is ongoing right now where they're actually looking at other sun-like stars and trying to figure out, "How big can these things get?"

Right now, to my knowledge, there's not a consensus. We haven't reached a point in the science yet where they say, "Yes, this is how big it can get." We're not there yet.

From a response perspective, speaking for FEMA, response organizations, and emergency management, we treat this the way we treat other natural hazards. We always look to an analog in another natural hazard.

A lot of times, we talk about geomagnetic storms in terms of hurricanes, but I actually have come to, over the last year or so, realize that we really shouldn't be talking about hurricanes. We should be talking about tornado outbreaks, because how do we respond to a tornado outbreak in the United States?

We know kind of where it's going to be. We kind of know it could be bad, but until these things actually strike and do damage, we don't know, "Where's the impact? What response do we need [?] to mount?" Right now, the same as true with space weather, regardless of whether it's a 50-year event, a hundred-year event, or a thousand-year event.

What we need to do is we're going to have to actually sit, wait, figure out, "Where did the impact actually happen?" and then mobilize a response based on that.

Regardless of the scale of the event, from our perspective, we're going to treat it the same way, this current way we do response to tornadoes. It's going to be a similar, larger type of response, but the same concept.

Ken Friedman: Industry would prefer not doing thousand-year events. Industry would prefer that we do events that are in some way realistic that it's like the asteroid. Will there be an asteroid to destroy all life on earth? They don't know how to deal with that.

That's a similar problem that we have in a sense with nuclear war. [inaudible/indecipherable] direct nuclear attack. We leave that to DOD to try to address, and hopefully it's never going to happen.

Jack Anderson: Kenyetta, do you want to say anything about catastrophic considerations of the [indecipherable]?

Kenyetta Blunt: Actually, Mark summed it really good. What we really are doing in the emergency management community is really trying to take a look at it as a maximum of maximum worst case scenario, planning towards that and making sure that we're looking at large-scale events, "How would we go about responding?"

As Mark said, because we don't know exactly who's going to be impacted, the population, where it's at, when it's going to occur, what's the damage, we really are left waiting until after the event occurs to then go ahead and mobilize a response. Hopefully, the preparation, the planning, and everything that we've done to prepare for it is adequate.

We realize at times perhaps it isn't because it's going to be a little bit worse, but we're also prepared to go ahead and try to continue to scale up to be able to address whatever the needs are should it be more than what we had originally planned for. We're always trying to remain flexible to be able to address whatever the situations are, whether it is as a result of a space weather event, hurricane, tornado, or even an earthquake so that we're able to go ahead and to make people's worst day a little less worse.

Ralph Stoffler: As you know, DOD lives in this environment. We prepare for contingencies all over the world. Ultimately, that's what we're all about. As an earthquake happens, typhoons hit some place in the Pacific, or whatever may occur, we've got trained people and equipment that can deploy to restore power, bring fresh water in, and do all kinds of things. That goes into the job charge of DOD.

The question is, what's the scope? We certainly plan for these kinds of things. We're ready to respond, but our resources, like all the other agency resources, can be overwhelmed if the scope is too high, and then it comes down to a resource decision.

When I was younger, I used to drive an older car that would break down periodically on the road. I went to my mechanic buddy, and I said, "What can I do to prepare for this? Should I buy some spare parts?" He smiled at me and said, "I can sell you a truckload of spare parts, and it still may not be the right one."

That's where it really comes down to. We do the best preparing for what we can within the resources we have, but you can't plan and have the resources for every possibility. That's why you've got smart, intelligent leadership that reacts and develops plans on the fly.

Jack Anderson: That takes us right up to our time, so a round of applause again for our panelists. Thanks very much.

[applause]

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