SECURE WORLD FOUNDATION

Promoting Cooperative Solutions for Space Sustainability

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Space and the Arctic

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Victoria Samson: Good afternoon, everyone. Thank you for attending today, which I won't say is like the Arctic, but I'm from LA, so as far as I'm concerned it is.

My name is Victoria Samson, with the Secure World Foundation. We're very excited about this panel of experts. This topic is a relatively [inaudible 00:42] your request. I look forward of learning a lot from expertise in this panel.

I know most of you, but, for those who are new to the organization, the Secure World Foundation is a private operating foundation that works to promote the long term sustainable use of space. Largely because it is intensely tied to our daily lives, our economic activities, and national security.

Our interest in space is not just for its own sake, but for what it can bring for socioeconomic benefits on Earth. As such, we also look at how space can be used to enhance human and environmental security, which is where our interest in the Arctic comes in.

The Arctic region is changing rapidly, allowing for new opportunities to learn more about this remote area, use it to expand economic development, and built off it for national security and political benefits.

However, there are challenges involved in ensuring that there is assured access to the Arctic. Monitoring the physical changes is undergoing, using the Arctic in a sustainable manner, and creating a stable environment for a region that could set off geopolitical tensions.

These challenges have created the need for scientific and technological approaches to conservation, resource management, conservation, and governance of the Arctic region.

Space-based assets are a critical element to providing the information and infrastructure to develop some of those solutions. Space, through remote-sensing satellites, plays an important role in monitoring the changing conditions in the Arctic, both those caused by humankind, and that which is naturally occurring, and enabling the management of resources there.

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The Arctic region also depends very heavily on space assets for communications and for situation awareness, primarily maritime [inaudible 02:21] awareness.

Given that the United States will assume the chairmanship of the Intergovernmental Arctic Council this April, and that the White House, just last week, issued an executive order to coordinate US Arctic policy, this timely -- we hope -- panel discussion will examine the implications of changing Arctic conditions.

What the United States and international community are and, perhaps more importantly, are not doing to meet those challenges being created by those changing conditions, and how space can help improve our understanding of and mitigate the disruption from those changes.

When you guys came in, you should have all received bios of our speakers. I will skip right to our first speaker, Mike Young, State Department. Thank you.

[pause]

Mike Young: Hi. Thank you, Victoria, and thanks to Secure World Foundation for hosting this great event. I'm probably the only speaker you've had had that's not a space expert, that doesn't know much about the capabilities and limitations of space.

I get the easy task of being able to wish for and say these are all the things that we want space to do for us and the Arctic weather and not be constrained by loss of physics or any other limitations.

[laughter]

Mike: I'll leave that to the rest of my panelists. As Victoria said, "The Arctic is changing." It's undergoing a great deal of change these days. One of the big implications that is already starting to be seen from that and is anticipated even more so in the future is the increased level human activity in the Arctic.

We, in the United States government and Arctic countries around the globe, need accurate and timely information to be able to make the right policy decisions now, with respect to the Arctic. Having that information is critical. We need to know what's going on.

We already get a lot of information from space that we use for the Arctic and from the ice stats that used to be up. Then, the ice bridge currently going on now, has been able to provide a constant record to track, among other things, sea ice extent in the Arctic. There are many other things that we see that space can play a role in giving this information on the Arctic.

I'll talk about some of the challenges that we have in the Arctic. Now if the sea ice extent continues to recede in the Arctic, it has made more accessible areas of the Arctic Ocean for

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everything from shipping, including commercial shipping, tourism, oil and gas exploration, even undersea mining, and access to fishing grounds.

As we see fishing stocks look like they're continuing to move north, as the ocean water continues to warm, and a degree of it continues to move north, too. We don't know what those changes are, or how to predict them very well, and how to act on those right now.

The more information we have about what is happening in the ecosystem, and with respect to the ice, the better. There are tremendous opportunities opening up in the Arctic exploration exodus. Shipping routes and mineral exploration, but there are also challenges that this presents.

Part of it is because of the increased human activity in the Arctic is a challenge. Even if there was not human activity in the Arctic, the challenge of being able to tell what's going on in the Arctic and react to it properly.

The Arctic Ocean is suffering the effects of ocean acidification more than other regions around the world, just like the Arctic itself has been warming more than other areas around the world. The carbon dioxide that's in the atmosphere is more soluble in colder water, and it has more of it, so the water in the Arctic Ocean is more acidic.

We're seeing more acidification of the Arctic Ocean than other areas. That's potentially affecting marine life, subsistence hunting in areas, migration patterns of whales -- not by the acidification, but the sea ice extent. Polar bears and other marine mammals are also being significantly affected by these changes in the Arctic.

I don't know if there's a way to measure ocean acidification remotely, using remote sensing. Remote sensing has been used in many other areas, by seeing symptoms of what happens, and then taking those signals from those symptoms that happen and making inferences or determinations about the underlying cause for that.

Maybe there are ways for ocean acidification to be measured from space, as an example of something that's way out there, that I don't know if anybody has even looked at. But ocean acidification is one of the major areas of concerns on Earth right now, and one of the areas where there is not sufficient monitoring or observations, terrestrially, in the ocean, to be able to get a good picture of what is actually happening.

Other types of scientific observations that are probably already being used from space, and that can continue to help us and help is even more in the future. I've mentioned sea ice extent trends, methane tracking -- both methane that comes from thawing permafrost and methane that comes from any methane hydrates that might be melting and being released in the Arctic Ocean, glacial melting, itself.

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One of the things that we have used satellite tracking for, but we need more information on, too, is the shipping traffic that's actually there. I'll let Ron talk more from the Navy about how the Navy uses that.

I know that the shipping picture, the State of Alaska, as well as the other Arctic stakeholders around the Arctic Ocean, have told us that they do not have a good picture of shipping, because ships don't always say when they're going to be transiting your area.

That is a significant problem in the Arctic, because with an area that has so much ice and so many natural hazards, if the ship runs into trouble, you might not hear about it until they're actually washing up on the rocks. Then their fuel bunkers have already burst open, and you have a large oil spill. In order to respond to that in the Arctic, to get a ship up there or anything to even start responding to it, may take days.

These are some of the challenges that we're facing in the Arctic. Anything that helps us with knowing what's going on sooner, better, more in advance, is helpful.

The title of the panel today is "Sustainable Arctic Development." I'm the US representative, head of the delegation, to the Sustainable Development Working Group in the Arctic Council. We talk about sustainable development in our working group a lot. What is sustainable development and what does that look like?

It means several different things, depending on who the person is that you're talking to. For the indigenous populations in the Arctic, they don't want their traditional way of life to be changed by decreasing access to subsistence hunting resources. But they also want the right to develop economic wealth on their own land.

They have this struggle, where they want things to remain as they are for their traditional subsistence way of life. At the same time, they don't want anybody limiting them, based on what they can or cannot do with their land.

In trying to resolve that inherent struggle, and in defining sustainable development and being good stewards of the land up there, we, in the government, want to make sure that development is sustainable. Meaning, it takes into account how all stakeholders can benefit from development, and in a sustainable way.

Again, information is key in making those decisions. That'll conclude my remarks. I look forward to hearing from the rest of my panelists.

Victoria: Thank you. Next, we have Claire Parkinson from NASA.

Claire Parkinson: Thank you, Victoria, and thanks very much for inviting me here. I'll follow on Mike's comments in terms of I do have some slides here that will show some of the results for the sea ice and ice shoots. Victoria, the next slide.

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This one simply shows the extent of sea ice in the wintertime, which would be March, on the left, and, then, in the summertime, September, on the right. In the March case, it's an area of 15 million square kilometers. The area of the US is about 9.5 million square kilometers, so it's well over one and a half times the area of the US.

The area of Canada is about 10 million square kilometers, so it's about one and a half times the area of Canada that is covered by ice in the wintertime. In the summertime, clearly, it's a whole lot less, down to about five million square kilometers. Next slide.

Because the ice extends over such a wide area and has many impacts, this shows four, the ice is a strong insulator in-between the ocean and the overlying atmosphere. It also is highly reflective. An ice surface will reflect most of the solar radiation. That's incident on its sending that solar radiation back to space.

This is hugely important in the climate sense. Because of the presence of ice in the polar regions, that contributes to keeping them colder than they otherwise would be.

It also has impacts on many animals. The polar bear being the one that's most iconic and the one that people refer to most often. Also, walruses, seals, Arctic foxes, all the way down to little microorganisms that live their entire lives within the ice. The ice really does impact a lot of plant and animal species.

Amongst the animals that it influences would be humans. We definitely are impacted by the ice. The particular picture there is a schematic showing the impact on traveling through the ice, where it can be hazardous if you're in a ship. Of course, the ice helps us if we're on a dog sled instead of on a ship.

It's got many impacts. Because of the fact that it has many impacts and that it spreads over such a wide area of the Arctic region...NASA started getting imagery of the Earth back in the 1960s and '70s. Sea ice was one of the many variables that it wanted to try to figure out how can we best measure sea ice from space. Next slide.

We can see sea ice easily from space with visible imagery. Landsat takes visible imagery, that's the kind of radiation that our eyes see, and we see pictures, just like what we would see if we were up in a plane. This is great, as long as it's light out and as long as there are no clouds in the way.

In the Arctic, in the wintertime, it's dark for months at a time. The Arctic also has a very heavy cloud cover frequently. Therefore, in terms of our climate studies, we usually don't use the visible data. We usually use microwave data instead. Next slide.

The microwaves are coming from the Earth system. Therefore, sunlight is irrelevant. We don't need light. We can get our measurements all times of the year. If you pick the right wavelength

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in the microwaves, they can go straight through the clouds. Therefore, we can see through the clouds to get our data at the bottom.

The picture on the left was from the first microwave imager in space. It's from the Nimbus 5 satellite. It was a proof of concept instrument. It did a phenomenal job in terms of showing us that, indeed, we can find out something about sea ice and lots of other variables with microwave measurements from space.

However, there were lots of missing data. It was a proof of concept instrument, and it is nowhere near the quality of what we've gotten subsequently with the follow-on instruments. All those black areas are missing data. That's for a three-day average.

The image on the right, which is more typical of what we get now, you can see there's practically no missing data. There's a very little bit of missing data right smack at the pole, and that's simply because the orbit doesn't go exactly to the pole. The image on the right shows the advance that we've had in the measurements through the microwave imagery. Next slide.

At first, in the 1970s and 1980s, we were basically looking at the microwave data to try to figure out what can we see about the sea ice. We saw a lot of things. We saw that it was a lot more variable from one year to another than people had guessed. By the end of the '80s, it became clear that we also would like to see what kind of trends we're getting.

By the end of the '90s, these trends had become clear. Not as clear as they are now but still clear. The top image here shows a plot month by month of the ice extent in the Arctic from the follow-on instrument of the Nimbus 5 satellite. The follow-on instrument was Nimbus 7. It was launched in late 1978, so that's where our data starts here.

Month by month, you can see that every winter there's way more ice than in the following summer. That seasonal cycle is so strong that it does dominate. If you only have the top picture, it's not all that obvious that there's a strong trend.

We remove the seasonal cycle to get the bottom picture. Removing the seasonal cycle, then, shows this trend that is clear by the time we published this. We published it in 1999. The data went through 1996. At that time, only three years behind, this was pretty good for that time. Now, of course, we have data up until yesterday. Again, advances in what we can get from space.

This particular set of plots came up roughly the same time as results from a group from the University of Washington, where they took submarine data to look at the thickness of the ice. They found a significant thinning of the ice cover.

Here, we've got this combination of NASA showing the retreat of the ice spatially, as indicated in the bottom plot there, and the University of Washington showing a thinning of the ice. This hit

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the news. I think the combination of the two was very powerful, at the time. Since then, many, many more people are interested in sea ice in the Arctic and, also, in the Antarctic. Next slide.

Indeed, the sea ice retreats have become like a poster child for climate change now, as illustrated by this cover of "Time" magazine from back several years ago. Polar bears, also, have become iconic in this realm of global warming impacts. Next slide.

We have continued to update our plots. This plot goes through the end of 2013. You can see that there were two really steep decreases in 2007 and 2012. In 2007, in particular, for those of us who had been working on sea ice for many years, it was remarkable how much that sea ice plummeted.

This would be September and October of 2007. Some scientists and others, at the time, were saying that we could have an ice-free Arctic a whole lot sooner than had been predicted previously. Some were even saying it might happen within the next few years.

Fortunately, in the subsequent couple of years, there was some rebounding. In 2012, it went down further, and it's rebounded a little bit in the past two years. Next.

September's the month that people talk about most. That's because that's when it gets to a minimum each year. Here are those two extreme cases of September in 2007 and September in 2012. You can see in the 2007 case, the upper left, that you can really do a very easy northwest passage, but northeast passage you would still have some difficulties.

You could see in the 2012 case that the northeast passage you could just sail through that really easily that year. There is inter-annual variability here. Last year, there were 10 recorded cases of ships that did successfully do a northwest passage last year. Next slide.

Even though September is the month that tends to be highlighted, every single month shows a negative trend. This plots month by month what the trend is over the period since 1979. You can see that every month is a negative. At the top of the scale is a -30,000 square kilometers a year. At the bottom of the scale is -90,000 square kilometers per year.

Area of Maryland is like 32,000, 33,000 square kilometers. Every month is showing a decrease of ice that's significant, a decrease per year. Next.

We do update our results on a website, which is indicated down at the bottom there. This is one of several types of plots that we update every week. I left it through 2014 here so that you could see. The black curve is 2014. You can see it's not as low as either 2012 or 2007, but it is well below the previous decades. Next.

Another way of looking at it, and a way that's particularly relevant for polar bears, is the length of the sea ice season. There, too, we're seeing a prominent decrease in the length of the sea ice season.

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The prime result is the one on the right. The length of the sea ice season is decreasing in every place where it's in the red, brown categories. It's increasing in just a very few spots, mainly in the Bering Sea in the blue. The other two plots on the bottom left are showing what the same calculation gave when there was only 10 years of data and, then, when there was only 20 years of data.

You can see, as we've gotten more data it's becoming more and more overwhelming, the decreases in the Arctic ice. Next.

We do exactly the same sets of calculations on the Antarctic. This is put in to indicate that in the Antarctic, indeed, it's not the same results in the Antarctic. There has been an increase in ice. If you look at the slopes, you can see that the slope for the Arctic is way more.

In other words, the Arctic is losing way more ice than the Antarctic is gaining. The Antarctic is roughly a third gain versus what the Arctic loss is. Next.

However, last year, in 2014, there was press coverage in the Antarctic case because it reached its maximum from the satellite record period in last September. You could see that, yes, it's definitely high. That's definitely of interest to scientists, but it's really not relevant to the fact that the decreases in the ice are really important to the Arctic.

Sometimes people confuse the two. They say, "We don't have to worry about the Arctic because the Antarctic's going in another direction." The fact that the Antarctic's going in another direction doesn't mean we don't have to worry about the Arctic. Next.

Now, I've got two slides left that look at the ice sheets. The ice sheets are particularly important because there is a whole lot of ice left on the Earth. The overwhelming majority is in the Antarctic ice sheet, and the next overwhelming most amount of ice left on Earth is in Greenland.

Enough ice in these two ice sheets to raise sea level by about 70 meters. Huge amounts of ice left on the Earth, but mainly in those two locations. Therefore, since this has the potential of really being important to humans if sea level rises...

The Earth can take it. The Earth's taken much greater sea level changes in the past. The Earth can take it. It's humans that are going to have a problem if sea level rises. NASA has, for many years, tried to make measurements of the ice sheets. These are visible pictures, but in the next slide we'll see some results from ICESat, which Mike had mentioned in his comments.

From ICESat on the left. ICESat was another proof of concept type instrument. It's a laser altimeter. It's certainly showed that with laser altimetry we can get information about the ice sheets. This shows changes in the Greenland ice sheet from the laser altimeter on the ICESat satellite.

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As Mike said, ICESat's no longer up, but there's this bridge measurement program with aircraft measurements that's called IceBridge. It's bridging between the ICESat measurements and ICESat-2 that will be launched, we hope, in a couple of years.

On the right is a whole other concept of measurements. It's from the GRACE satellite, which stands for Gravity Recovery and Climate Experiment. It's very unusual in terms of it's got two satellites tracking each other. It doesn't have any instruments pointing at the Earth, and yet it's giving us information about the Earth.

The way that it's doing that is it's keeping close track of how far away these two satellites are. As one goes over a heavy gravitational field, it speeds up. Therefore, the distance between the two gets greater. As the other goes over that same heavy gravity field, it catches back up again in terms of the distance between the two.

With that gravity information, you're able to tell changes underneath and, in particular, the Greenland ice sheet. The GRACE satellite has shown decreases in the mass of the Greenland ice sheet. I'll leave it at that. NASA's making lots of measurements relevant to the Arctic.

We tend to emphasize the measurements rather than making policy recommendations. We're always told we can make whatever recommendations we want, but if we make recommendations it's got to be as a private US citizen, not as a NASA employee. Thank you.

Victoria: Thank you. We'll be doing a quick switch. In the meantime, we'll be starting with Charity Weeden from the Canadian Embassy.

Charity Weeden: Hi. Thank you, Victoria and Secure World, for inviting me to this panel. There we go. My fellow panelists have already mentioned some great applications that space can bring and their effects that Arctic environment changes have on Earth and the people of the Arctic.

Today, my remarks will focus on Canadian viewpoint of where and how space and the Arctic intersect. The Arctic is a special place. Fragile, yet full of opportunity, both domestically and collaboratively. As its access increases, so does its economic potential and human footprint.

How the region evolves is of utmost importance to Canada, as an Arctic leader, and is embedded in our national identity, reinforced by our national anthem when we sing about "the true north, strong and free." Access to space-based capabilities is integral to the safety, sovereignty, economic prosperity, and way of life for Canadians working and living in the Arctic.

Indeed, as interest gains in the region, space will play an even greater role in its development. The four pillars of Canada's northern strategy are ideal in helping to identify how space supports our national interests in the region.

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First of these pillars is exercising sovereignty over Canada's north. Much of Canada's vast north is a harsh environment and difficult to reach, consisting of 1.5 million square miles, an area about the size of the Indian subcontinent. It makes up 40 percent of Canada's total landmass, and is home to 115,000 Canadians. That's one-third of one percent of our national population.

Canada is also a three-ocean nation, with two-thirds of our 150,000 mile coastline in the Arctic. Of the 77 communities north of 60 degrees, 28 cannot be reached by road or rail.

While it takes a suite of land, sea, air, and space capabilities to monitor this region, the unique qualities that satellites play in reaching isolated areas shows how ideally suited space is to monitor, navigate, and communicate. Basic requirements to support sovereign operations in the north.

Remote sensing satellites and, in particular, synthetic capture radar provide wide area detection of transits through the Canadian archipelago, fishing, or instances of pollution, day or night, in any weather. Space-based automated identification systems, or AIS, further identify and track maritime vessels, helping decision makers narrow down where to send air and sea assets.

Global positioning satellites aid in the navigation of territory when inertial systems drift closer to the North Pole. Finally, satellite communications pass vital time-sensitive information in the event of a search-and-rescue effort or an environmental disaster.

While communication gaps still exist in the Arctic to support safety and sovereignty operations, the government of Canada is pursuing solutions like polar communication and weather, PCW, to provide access to secure, highly reliable, and high capacity telecommunications systems in this under-served region.

It's true that space technologies do not replace humans and infrastructure on the ground, but they are naturally suited to reduce gaps where physical presence is extremely difficult to maintain and provide critical support when conducting operations in the Arctic.

Secondly is promoting social and economic development. In the fall of 2011, Anik F2, a telecommunications satellite that serves the North, encountered a software malfunction. While you or I likely did not notice, 39 isolated communities that received phone service via satellite across Nunavut, the Northwest Territories, and the Yukon certainly did.

The malfunction also affected Internet connectivity, ATM access, debit machines, and even grounded flights. It goes without saying that assured, affordable, high-speed Internet access is critical to the economic development of the North.

While there are fiber and microwave options in a very few, select communities, sadly, broadband of up to three megabits per second is currently the only limited option for the majority of our Arctic people.

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As an example of usage of this technology, tele-education and tele-health services can make positive impacts for communities who would not otherwise have access to specialist doctors or professors.

Further, weather data and ice monitoring from space is providing information necessary to allow barges, merchant, or cruise ships to safely conduct business and increase the economic footprint of the Arctic.

Connecting Canadians, no matter where they live, is a fundamental reason why Canada became the third nation in space in 1962 and why we were the first in a series of communication satellite developments, including mobile services and domestic geostationary communications.

As economic development increases through mining or hydrocarbon exploration, tourism, or other innovative opportunities, space-based systems are surely to play a central role.

The third pillar of our Northern Strategy is protecting our environmental heritage. Canada's north has fragile and unique ecosystems, which are being affected by the impacts of climate change. It's important to understand and protect these environmentally sensitive lands and waters. Space-based capabilities are playing a significant role in doing just that.

The atmosphere chemistry experiment on Canada's SCISAT satellite has been measuring stratospheric composition and ozone levels in High Arctic and around the world for the past 11 years. Its data are making an important contribution to international environmental policy making.

RADARSAT-2 and other remote sensing satellites are measuring both the extent of ice and whether or not it's multi-year ice. An important indicator for the pace of warming in the Arctic, which affects the habitat and migration patterns of Arctic animals.

As permafrost melts, this technology can also monitor vegetation changes and measure infrastructure damage. Weather information, much from satellite sources, underpins all activity in the Arctic. Any operation, whether land, sea, or air-based, requires accurate forecasting for safety purposes.

Should there be an environmental disaster, the effects are felt much more severely in the delicate Arctic environment. Detecting oil slicks or bilge dumps early helps to enforce regulations, expedite a clean-up response, and enable the prosecution of the offender.

Canada's final pillar in its Northern Strategy is to empower northern communities, providing greater control over their economic and political destinies. Space-based tools are at their disposal to enhance education, healthcare, and social services.

Self-governance is supported by space through being able to independently monitor resources and communicate with businesses looking to invest in the North.

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I've been discussing how space capabilities bring benefit domestically to the North, but I'd also like to note that space and the Arctic are natural domains for collaboration. The Arctic Council is the leading multilateral forum that has produced consensus on search-and-rescue operations in the North, enhancing ship safety, and protection of the Arctic marine environment.

We all benefit from NASA, NOAA, and ESIS science satellites to help understand and monitor the atmosphere and weather patterns in the Arctic and around the world. The sharing of ice and weather data is a public good that can save lives and prevent ecologic disaster.

As with many of our space efforts, Canada looks to partnerships for mutual benefit and to obtain services and technologies that would otherwise be unavailable. After all, what affects one affects all of us.

Clearly, space-based capabilities bring positive value to Arctic activities, whether through monitoring the environment, providing safety and security, or developing economic opportunities. Space assists Canada's commitment to be a consistent champion of the Arctic, and do so in a manner that is peaceful, responsible, and in the interest of all Arctic nations.

As I close, I wanted to give you a literal example of where space and the Arctic intersect. I have an image...

Victoria: That's loading. [laughs]

Charity: ...that's loading. [laughs]

[silence]

Charity: That's OK if it doesn't work. It's the aurora borealis. Exactly, literally, where space and the Arctic intersect. It's beautiful. It absolutely is beautiful and stunning to see the northern lights dance around. With that, I thank you for inviting me, and I welcome any questions you have afterwards.

Victoria: Thank you, Charity. Maybe it'll show up at some point. [laughs] In the meantime, we'll have Amy Sun from Lockheed Martin talk about her work.

Amy Sun: Hi. Thank you for having me. I'm from Lockheed Martin. We're the prime contractor for the nation's next generation tactical SATCOM system, the Mobile User Objective System. This is an evolution of a tactical SATCOM system beyond line-of-sight communication system. What's been exciting recently is this type of communication has been important since about the '70s.

Traditionally, we've had incremental improvement on the technologies that give us more gain, better coverage, better links, faster data rates. Recently, with the Mobile User Objective

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System -- it's MUOS for short -- there's a revolutionary change in the underlying technology. We've discovered that we are able to close high data rate links well into the Arctic.

This is pretty exciting because MUOS is a geosynchronous constellation. When you design a space-based system for Arctic or Antarctic coverage, you find that, traditionally, you have to go into funny orbits that have their own difficulties or different considerations. The geosynchronous orbits are very well-understood from a users' and Earth observers' perspective.

The satellite essentially stays in the same place for pointing. It's symmetric for the Arctic and Antarctic. It has a more benign or stable space radiation environment. It's really desirable, if you can, to extend your, in my case, communications capabilities from a geostationary or geosynchronous orbit rather than these more difficult Arctic-reaching or Antarctic-reaching orbits.

Recently, in 2013 and 2014, we, along with a group of other vendors, have ventured into the Arctic and Antarctic, proving that we are able to make these links. It's been pretty exciting. We've flown over the North Pole in a C130. We've gone out on the Navy's ice camp and maintained, essentially, network Internet load, network connections for the duration.

We've also recently participated in a search-and-rescue-like activity in the High Arctic over Canada, as well as the icebreaker Healy while it was transmitting. One of the exciting things about having a geosynchronous system is you don't have separate networks for, say, just an Arctic network and just an Antarctic network that you then have to bridge into your equatorial or otherwise global network.

It is the same network, so we expect the same performance, be it latency or quality of service or coverage. I'm going to stop here because I want to break out in equations now, but I welcome any questions.

[laughter]

Ron Piret: I'll just say thank you for stopping before the equations part.

[laughter]

Claire: Before we pull up your presentation, please, enjoy the aurora borealis.

[laughter]

Claire: We'll be pulling up his presentation. I guess you've readied his slides? Please.

Ron: There we go. Thank you, Claire, and thank you to the Secure World Foundation for having us. I'm Commander Ron Piret. I work for the Navy's Task Force Climate Change in the office of

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the Oceanographer of the Navy, Admiral John White. Give my regrets for Admiral Titley. Some of you were probably expecting to see and hear him this morning.

He gave me some of his notes, so hopefully I can carry some of the water there. Next time, Claire, too, I think I would like to go first. After all these smart people have their say, cleaning up last, I feel like there's a lot of great work going on. The Navy's looking forward to leveraging some of that inter-agency work as well as international partnerships.

We've been thinking about the Arctic for a while. We've been operating in the Arctic for a while. It goes back into the 1700s when the Genetics Commission went up there with Lieutenant Commander Dewan. Not such a successful endeavor.

However, we have been continuing to operate in the Arctic continuously with our submarine fleet since 1958, the nautiluses surfacing at the North Pole at that time. We can go ahead and go to the next slide.

Obviously, the Navy's been aware of the increasing access to the Arctic. Unlike Dr. Parkinson's good radar images, this is the Navy's colors and pictures and our depiction, if you will, of what we see the future looking like. Trying to tell a story, effectively.

Back in 2009, Admiral Roughead obviously saw that the Arctic was starting to open up. We can see the impacts of climate change from a security perspective. He turned to Admiral Titley, the then Oceanographer of the Navy, and asked him to stand up a Task Force Climate Change. Take a look at some of these problems and what does it mean for the Navy and the nation as a whole.

We wrote our first road map in 2009, really doing assessments and studies, trying to figure out what don't we know. Where are we now in terms of our capabilities? What questions are we not asking, at that point in time? We had a lot of success with that, and we did identify a number of things that we needed to work on to start asking those questions.

In collaboration with the Office of Naval Research and a lot of their partnerships, again, with the inter-agency and international, we pursued those lines.

Fast-forward again. We had ice minimums in 2007, 2012, and, again, we're starting to talk more about climate change. Admiral Greenert, our current CNO, now asked Admiral White, the current Naval Oceanographer, to update that road map. "What do we need to do? We've done studies, we've done assessments.

Now, what do we need to do to prepare? By the way, I'd like to know, Admiral White, when is the Arctic going to be accessible to human activity?" There are some smiles in the audience, so you know that's a pretty hard thing to do. I'm trying to model things.

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What you're seeing up here is really our depiction of when we see the Arctic opening up about mid 2020s in terms of, perhaps, a transpolar route being accessible for maybe two weeks or so in the mid 2020s to 2030 time frame.

What are the implications of that, and what does the Navy need to do to prepare for that human activity? Also, our formal job is securing the nation's interests with regards to that. We can go to the next slide.

Part of the road map update was taking a look at our strategic objectives for the Arctic region. Frankly, it's much similar to everywhere else we are in the world. We ensure our sovereignty and provide a defense. We have to provide ready Naval forces for any sort of contingencies or crises that may occur, whether it's with our friends or for ourselves.

Certainly, preserving freedom of the seas and access for not only global trade and economic development, not for just ourselves but, again, for our allies. Then, opportunity to promote partnerships, both within our own government and with our international allies.

We produced a road map. There's a lot of focus on leveraging those partnerships. There's a lot of talk about budget austerity, and the Arctic is no different. We have to look for those opportunities, particularly in a region where we have a lot of close neighbors, and we share a lot of borders in that region.

The Arctic Council has stood up, in effect of that, to recognize that with shared interest also comes opportunity for cooperation and helping each other out. Ensuring that the native peoples who live above that 60 degree line also prosper at the same time other nation states do, as well. We can go to the next slide.

These challenges, I think everybody can recognize them. They're common, regardless of service or nation. Our partners have many of those same challenges, whether it's ability to operate in that environment, the limited communications and satellite sensors.

We have a lot of experience in the submarine fleet, but, full honesty, the surface fleet hasn't had a need to go up there in a number of years. Certainly, the Coast Guard has maintained that presence and ability in the Alaskan waters with the Polar Star and the Coast Guard cutter Healy, as well, and some of their summertime deployments.

Search and rescue assets, we have two agreements now within the Arctic Council for search and rescue and hazardous spill response. Again, a lot of those things generally fall toward the Coast Guard first, but we work in cooperation. We need to identify those instances where we think we need to complement those Coast Guard activities with regards to that.

Putting on my oceanographer hat quickly, we identified some gaps in terms of how we sense that environment and how we forecast in that environment as well as predicting? Providing the

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operators some sense of this is what's going to happen up there, and you need to plan appropriately. If we could, go to the next slide.

We built this plan in order to try to address these things. There are a lot of great efforts going on right now. I think you need one more click with regard to that slide, or maybe one more after that. Sorry, I didn't realize I had animation in there.

It's almost been a year next month that we signed out this road map. It's divided into two parts. The first part is the strategy and our focus and how we think about the Arctic. We do think about the Arctic as a place where we have a lot of opportunity to work with our partner Navies up in that region.

Continue to develop those relationships so it remains an area of cooperation and shared interest, as the national strategy also promotes it. We also, then, broke it down in terms of the time frame. As the Arctic is going to become more accessible, what do we need to do? In good acquisition process, we need to figure out do we have the right equipment?

What are our requirements? What are our enablers with regards to that? That's some Department of Defense speak, but if we go to the next slide, enablers are really about what does it take to operate up there safely. What does it take to take a ship, an aircraft, a sailor, soldier, airman, and be in that environment?

That not only allows us to operate there safely, but this also has economic impacts with regard to the people who work up there, whether it's the petroleum industry, whether it's the fishing fleets migrating to the North, whether it's mining operations, and so on. These are all the things that we really need to solve and get at so that we humans can work in the Arctic.

Not only in a sustainable, economic fashion, but also with regards to stewardship. That all links together.

Under law, if you will, Title 10, the Navy's responsible for the safe and effectiveness of all the maritime traffic, whether it's aircraft, forces, or any sort of allied shipping on the water. That's not from a commercial aspect, but it's for the coast guard, our own navy, any of our survey vessels that might go up there, as well.

We first need to understand that environment, understand the physics in that environment, and then apply that in improved modeling, high resolution modeling, and coupling the air and the ocean together. That's not something that we do extremely well right now.

We have efforts ongoing, not only regionally, but globally. Some of you may be familiar with the Earth System Prediction Capability. Again, that's a number of agencies that are working together now to have a globally air-ocean coupled high resolution model in order to predict weather, and have ice characterization, and things of that nature, with regards to that.

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Again, how does space come into all this? Obviously it's a tough environment.

If you ever tried to put a tide gauge in the Arctic, or anywhere else, or put a buoy in the water, nothing wants to stay for very many seasons, right doctor? Remote sensing and satellite-based capabilities are really a key factor for us to get synthetic aperture radar and the imagery associated for ice prediction, as well as communications for the safe operation of vessels up in that area.

Major Weeden also mentioned about AIS, or what we also use in terms of maritime domain awareness. What kind of ships, who's going up there, understanding the risks involved.

It's very fragile ecosystem and knowing the cargo, the type of vessel, where it's coming from can allow us, then, to increase our response with regards to the search and rescue, or figuring out what kind of risks and risk models we're having up in that region.

As Mike noted, Alaska and the leadership in Alaska really wants to know who's transiting through the Bering Strait in their backyard that may impact their economic livelihood for the people on the North Slope, as well.

I'll leave it there so that we have time for questions. I appreciate the opportunity to speak in front of the group. Thank you.

[applause]

Victoria: Thank you, Ron. We'll have time now for questions and answers. I'm going to ask you to please wait for the mic and identify yourself.

In the meantime, I thought I'd start off with a question I had [inaudible 55:59]. It's from the panel.

Mike, I'm wondering if you could talk a little bit about the US upcoming head of the Arctic Council. Are there goals or objectives that we'd like to accomplish for the role, and how can international cooperation work on that?

Mike: I don't want to take up the rest of the time here. That's normally the topic that I get to speak on the most. I wanted to relate it to space, but as I was listening to the other panelists speak I was thinking of areas in our chairmanship program that tie in to that.

Canada right now is the chair of the Arctic Council and the US will be taking over this chair of the Arctic Council in April of this year, in a couple months here. We have proposed some ideas for our program of what we would like to do during our chairmanship role. We would like the entire Arctic Council to work on during our chairmanship.

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A couple of those areas do have direct relevance to what we've been talking about today, and one of those is telecommunications in the Arctic. Every panelist up here has talked about why communications are important in the Arctic and what role they play.

Right now communications in the Arctic need to be drastically improved in order for us to have better search and rescue capability, better services to the inhabitants of the Arctic, both from simple emergency communications, all the way up through having broadband Internet access for telemedicine, for education, for everything else that the rest of us start to take for granted that we have access to and benefit from by having broadband Internet access.

Having been to the Northern Slope of Alaska and seen what the Internet rates are on your phone, data rates and that, you realize how much you rely on that and take it for granted when you're not in a place that has it and you see everyone else having to live day to day without that. Telecommunications will be a big emphasis of our chairmanship, and there are multiple other areas.

The effects of climate change in the Arctic, and understanding those, and being able to take actions to improve the resilience and adaptability of residents in the Arctic is also an area we want to focus on. I think that, as mentioned, knowing what's happening by getting information from satellites and from space will help with that, as well.

We have an ambitious program during our chairmanship. We've got three areas, improving economic and living conditions of residents in the Arctic, addressing the impacts of climate change in the Arctic, and then also safe and secure shipping and stewardship of the Arctic Ocean.

Those are the three areas. Then, as a side thing after that that we as the US want to get out of it, we want to improve the awareness of the American public of what's going on in the Arctic and help make sure that American citizens are aware that the United States has Arctic territory by having Alaska.

A significant part of Alaska is in our Arctic. American citizens are affected by it, so we want to make sure that American citizens are educated about that through public relations campaigns.

Victoria: Building off that, Charity, Canada is the current head of the Arctic Council, yes?

Charity: That's correct.

Victoria: Legacy? Things you guys want to accomplish in the next couple of months? Things you guys have accomplished you're very proud of?

Charity: If you allow me, our Arctic subject matter expert from the Canadian Embassy is here.

Victoria: Of course.

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Charity: Nicola, would you like to answer that?

Victoria: Would you mind using the mic, and could you give your name, please?

Nicola: Hi, [inaudible 60:03]. My name is Nicola [inaudible 60:04]. I'm responsible for Arctic issues writ large at the community. I'm seeing out there, obviously, Cherokee and others are experts on specific things, but in particular I cover [inaudible 60:18] the Arctic Council.

I don't want to assume what decisions will be taken by the ministers at the end of April, but I think some key issues for us were on black carbon and methane challenges, which impose or have a big impact on people living in the Arctic. [inaudible 60:51] has planned to take this forward.

I should add that the Arctic Council is a consensus-based organization, so we're going through the process of discussing the US proposals. Hopefully we'll have the program agreed to by the end of [inaudible 61:13] April.

Another key thing for us is the Arctic Economic Council, which is an independent body that was agreed to by ministers in 2013. It's for businesses to exchange best practices, to coordinate east-west, because pretty much all economic activity happens north-south.

The third part of our chairmanship is raising awareness about traditional life, traditional and local knowledge. Complimenting western science with what the people who are living there actually have seen for themselves.

I know there are several examples of that where, often, Western scientists only go up in the summer, and stuff like that. People live there year-round also have a long history to [inaudible 62:18] reflect on what they're seeing, how does this fit in with Western science, and meet the rigors of that, but also [inaudible 62:27] that importance.

I could probably talk for a long time about Canada's chairmanship priorities. One last thing is the agreement on oil preparedness and prevention, how to deal with that particular challenge.

I'll end there and pass it over to other questions.

Victoria: Thank you. I didn't mean to put you on that spot, but that was very helpful. Thank you.

Mark Brender: For Mr. Young, I'm Mark Brender. I'm the Executive Director of the DigitalGlobe Foundation. Of course, DigitalGlobe, the company, owns and operates high-resolution [inaudible 63:11] imagery satellites.

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With the change in the Congress' control and the upcoming chairmanship, do you get any anecdotal sense from the appropriate new committee chairman how they're going to look at the Arctic now that they are in control of all the changes?

Mike: Senator Murkowski has made well known that...She's always been a big supporter of the Arctic and wanting the federal government to be more involved in the Arctic. Now that she holds a prominent position on a couple of different committees with appropriations, she has indicated that she would like to maybe use that to help support Arctic development in whatever way she can.

As far as how the details of that will be worked out, I don't know what she has in mind or how that will work its way out amongst the rest of the members of Congress and, then, once it comes to the executive branch. I know there's a strong interest there, yes.

Victoria: Next question.

Melissa Hersh: Hi. Melissa Hersh. I'm a risk consultant. I have a more geo-political question that would go, probably, to the State Department and to the Navy. Maybe a little bit to Lockheed. Basically, with the US taking the helm of the Arctic Council, what's likely to be the information exchange between the US and Russia?

Predominantly based on the seemingly tactical advantages that Russia's had in the Arctic and based on the current relationship.

Mike: With regards to Russia, the United States, despite the sanctions we have on Russia because of their actions in Ukraine, which we are obviously going to keep in place and keep trying to influence Russia to withdraw from Ukraine...

The Arctic is a region where cooperation with Russia is in our own national interest, and it's in the interest of the entire region. It's in Russia's national interest to cooperate in the Arctic internationally, as well. Both sides see that, so both sides want to maintain that cooperation in the Arctic.

Has it been affected by what Russia did in Ukraine? Of course, but both sides are trying to minimize that effect to maintain the degree of cooperation that all of the Arctic countries share on Arctic matters. How that will eventually play out, I don't know. So far, how it's played out in the Arctic Council is there have not been any detrimental effects to that.

We still enjoy discussions in cooperation with Russia on Arctic Council matters.

Victoria: Other thoughts?

Ron: I can comment briefly. Certainly, we take a guidance, with regards to our relations with Russia, from the Department of State. We had been having several discussions up until the

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situation in Ukraine occurred. Since then, those conversations have become much less frequent with regards to that.

I will say, though, that we have hopes for collaborative efforts in the future. Those differences can be resolved. There are lots of opportunities in the Arctic with regards to charting and information sharing that would benefit both nations.

Victoria: Thank you. Other questions?

Jim Mako: I'm Jim Mako from the Clinton Foundation. I was interested in your thoughts about the increasing push by the oil industry to do more drilling Obviously, there was an article in the "New York Times" about there being a platform and had some problems. There's a continual push, and as the ice declines there'll be more.

That will, obviously, have an impact on all that's happening in the Arctic. How does the panel feel about that push by the oil industry?

Claire: I can start out, Jim, since I've worked on the Arctic for so many years. From very early on, many of us in the scientific community see that this is a danger. We really wish that minerals and oil and other valuable things would not be discovered in the Arctic or the Antarctic, because we see the potential of the environmental destruction coming because of that.

Again, this is clearly stated as an American citizen, not as a NASA employee here. Certainly, with the opening of the northwest and northeast passages, oil spills are going to become much more likely because more ships are going to be up there. Then, with the drilling, as you mentioned, also, disasters are much more likely.

As a scientist, it's a definite concern.

Victoria: Other thoughts?

Charity: Yes. Interesting question. I read the article, as well. It goes to show that operating in the Arctic is still not an easy endeavor. Ice-free is not a word that is commonly used because it's ice-reduced in the summer, but navigating in the north is still an issue with knowing where ice is and boundaries, et cetera.

From a government perspective of making sure that the right infrastructure and the right responses to an emergency, search and rescue, or environmental disaster are clearly important and in our interest.

Mike: I'd like to comment a little on that, too. The US government's policy is that we are not opposed to oil development in the Arctic, but we want to ensure that it is responsible.

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I would say that, of the other Arctic countries, right now the US probably is the most leaning on putting more emphasis on the responsible side of that as opposed to the development side of it. Just by the nature of the different governments and different national interests around it.

We're not opposed to oil development in the Arctic at all. We need to make sure that it's responsibly done. The technology to be able to do that, right now, does not really exist. The technology to explore for oil responsibly exists, even though, obviously, you can't account for poor judgment, as in the case of the [inaudible 70:38].

The technology to actually produce offshore wells in the Arctic does not currently exist. One of the areas that we're working on in the Arctic Council right now is the task force on oil pollution prevention. That's two-fold. There's the shipping aspect that we've been talking about, if a ship runs aground or fuel bunkers are ruptured.

There's the other one, if there's a blowout from an oil well in the Arctic, which everyone looks back to Deepwater Horizon and things. If that were to happen in the Arctic, it would be so much more disastrous than it was, even, in the Gulf of Mexico.

Not only is it remote and you can't get resources there, it could potentially be under ice. The oil is mixing with the ice, not able to be cleaned up or disburse. When you talk about risk management for oil production, and including exploration, in the Arctic, the standard has to be so much higher offshore than it does for anywhere else in the world.

Like Charity was saying, the Arctic is not an easy place to operate, even with things opening up. There's been a lot of hyperbole in the media about how the Arctic is opening up, and suddenly everyone thinks, "Oh, it's almost like a step function. It was closed and now it's open. Everybody rush for it."

[laughter]

Mike: That's not the case at all. It is still very difficult to operate up there. There are technological challenges. We have overcome some of those technological challenges before. The oil companies have done some amazing things on the Alaskan north slope with their ability to develop the Prudhoe Bay fields and building the trans-Alaska pipeline system.

When you start going offshore, it's a whole different realm. If you're going to be producing offshore, you want to be producing 12 months out of the year, not just 1 month. Producing under the ice, you can't have a platform that's on the surface. No amount of structural strengthening is going to keep an oil platform on the surface from the sea ice engulfing it, and the sea ice moves.

Those forces are insurmountable. You have to either build an artificial gravel island, like we've done in some of the cases up at the north shore, which is basically creating a land-based shore, in shallow water that we're able to put enough gravel down. If you do it in water where you can't do

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that, you don't have a way of grounding it to the sea floor where the ice isn't going to be able to move it.

You have to be able to produce, basically, a remote well head that's produced from only under the ice in the dark. If everything goes great, that works out well, but you can imagine if you're producing remotely this well head and then something goes wrong to the pipeline. It goes up to the land. How do you respond to that and do that?

There are several challenges that need to be overcome in order to produce responsibly. We're not opposed to producing responsibly, but it does need to be responsible.

Victoria: Do you have a thought/question over here?

Audience Member 1: A follow-up question on that. In terms of underwriting and indemnifying any of the potential commercial operations in the Arctic, is the US looking to work with the private sector or are they looking to share some of that burden themselves? Is there a discussion on how that's going to take place?

Mike: I'd have to refer you to the Department of the Interior on that. I'm not familiar with those issues.

Audience Member 2: I'd just like to make a further comment echoing around what Charity and Mike have said, but also to realize that there are these two very distinct Arctics. It's important to note that, for example, Norway has been extracting oil and gas from its Arctic for about 50 years, so this isn't new. They're able to do this, however, in the Gulf Stream.

Canada has issued some exploratory, at least, but no drilling is actually taking place there right now because of the challenges that Mike has identified. The US and Canada face these huge challenges, but it's important to note that it's already happening in other parts of the Arctic for reasons, because it's very different there.

Victoria: Yes, nuances are very always important. We had a question in the front row? Can you guys back the mic, please?

Richard Rogers: I don't think I need it.

Victoria: We actually need it for the audio recording. Sorry.

Richard: Richard Rogers from Stellar Solutions. I have a general question. Can someone verify what the sovereignty situation is in the Arctic, where boundaries extend to and who owns what?

Victoria: Just for the record, before this event started, I asked, "Who's been to the Arctic before?" I was told, "There's many different versions of what the Arctic is." Actually, I have that question myself.

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Mike: As the State Department person, I'll take that, since it's a sovereignty question. This is another one of those things that's written about in the media that's not portrayed quite the correct way. It all stems from the extended continental shelf claims. Actual land in the Arctic, there's one tiny, little island that's disputed between Canada and the Kingdom of Denmark. [laughs]

Other than that, there are no actual land disputes. There are maritime boundary disputes. The US has one with Canada in the Beaufort Sea. What you're probably referring, based on those articles, is when they say that there have been these claims.

The Kingdom of Denmark just made a claim that they've submitted to the Commission on the Limits of the Continental Shelf to claim a huge area of the Arctic Ocean. Russia has previously claimed that. Canada, at the end of 2013, made their claim. Those claims are done through a very structured and scientific process through the Law of the Sea convention in Article 76.

It spells out, based on certain criteria, the symmetry and the sediment composition and everything of the ocean floor. If you can show that you meet the criteria that shows that beyond the 200 nautical mile normal limit of exclusive economic zone there's a natural extension of your continental shelf, then you can claim rights to the seabed floor and below.

It's getting those rights. It's not getting extra territory or land. Those rights could be very valuable if there are mineral resources under there -- oil, gas, magnesium nodules, whatever you have. The process for making those claims is you do a lot of research, testing and that, to find out what the composition of the seabed floor is.

If you have a ridge that extends from your continental shelf and you can prove that it's connected to your continental shelf, then you can say that that ridge is also an extension of your continental shelf and can make claim to either side of it.

There's a ridge that goes across the floor of the Arctic Ocean called the Lomonosov Ridge. It goes between, basically, right where Canada and Greenland come together all the way over to Russia. That ridge is one of the main reasons that creates the basis for all three of those claims.

All the Commission on Limits of the Continental Shelf will decide, which is a group of scientists, is whether your data that you provided is in accordance with article 76 and it proves that you have a valid claim. It does not arbitrate claims where there are overlapping claims between different powers.

In cases where there are overlapping claims, that's either a bilateral issue or, if there are more two places overlapping, a trilateral issue for those countries to sort out themselves, just like a normal maritime boundary claim. It's not if we don't grab it then someone else will get it type of scenario. Hopefully that answered your question a little bit.

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Claire: Regarding that question, I'll make the comparison with the Antarctic and how wonderful it is that way back in the 1950s the world did come together, or major countries did, and made the Antarctic essentially dedicated for peaceful purposes. All the major countries now have signed on to that Antarctic Treaty.

It'd be wonderful to get something like that in the high Arctic but not likely.

Mike: I'll point out that there's a very big difference, though, because the Antarctic is land and the Arctic Ocean is ocean.

Claire: Huge difference. Agreed.

Mike: Even legally, there's a big difference. One of the things, during our Arctic Council chairmanship, that we want to explore with the other Arctic states is whether there should be some sort of regional seas agreement or regional seas program where we can manage the Arctic Ocean in a way.

Just to explore the possibility of that, not saying we have an idea of exactly what that should look like. The Arctic Ocean is definitely a maritime environment, and it should be explored because it is very fragile and it's a very important ecosystem. The countries that border that ocean should explore the possibility of managing that ocean collectively.

There are areas of the Arctic Ocean that are on the high seas that, according to international law, it doesn't belong to anybody. Even with extended continental shelf claims, that's only for the sea floor and below. It's not the pelagic resources, so it doesn't involve fishing or anything like that.

When you talk about managing a regional sea, exactly what that would look like, that's something that we're going to explore.

Victoria: Building off of that, the International Maritime Organization adopted international code for ships operating in polar waters. I'm very interested to hear about that. For the space community, there are these questions of a code of conduct. I'm wondering if there is some sort of similar mentality for entities operating in the Arctic or not.

Ron: I'm not sure I'm understanding your question completely.

Victoria: I'm looking at the idea of is there a sufficient international cooperation to have some sort of code of conduct for countries that are operating, for example, maritime, to meet awareness in the Arctic? Does it need to be done via legal treaties, or can we do it in an agreement of what the norms of behavior for responsible actors in the Arctic?

Again, I don't know if that actually translates.

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Ron: It still might fall into Mike's realm, in some respect, with regard to treaties in the legal purview and the Law of the Sea, if you will. The nation states do recognize the Law of Sea. We do operate underneath those conventions. It seems to work well across the globe.

Mike: Speaking of the IMO, the IMO recently adopted the Polar Code. I'm not familiar with the code of conduct in space, so I'm not qualified to compare and contrast the difference between those. The Polar Code that was recently adopted by the IMO does require vessels to...

Legally, all vessels for all members of the IMO, which is pretty much everyone in the world, abide by certain regulations in both the Maritime Pollution Agreement and the Safety of Life At Sea Agreement. There are pollution standards that were adopted as far as boats discharging bilge water and, also, air emissions from stacks operating in the Arctic.

There's more that some people say the IMO could do or should do, but the IMO is a very large organization. You need to get everyone to agree to it. The Polar Code was agreed to, and that will be going into force soon.

Corey Springer: Thanks. Hi. Corey Springer from Ball Aerospace. There have been a number of mentions about methane in the discussions. That, in combination with the recent administration policy on methane reduction, is that translating into any particular program in monitoring or measuring methane?

Obviously, it's technically possible to do it from space. There are lots of advantages of doing it from space, but I'm wondering if that's actually translating to anything at NASA. Considering a question earlier, if so, how do you think that may actually get any traction with the new Congress?

Claire: [inaudible 84:24]

Amy: If I take off my Lockheed pin for a moment and I can say that this is maybe an area where the sharing of scientific data with Russia comes into play, the majority of trapped methane that can be released by receding sea ice is in the region north of Russia.

It's somewhat known or well-known in published literature that the Russians have had various kinds of monitoring and experimental programs looking at and predicting the release of methane. As far as I know the British, Americans, and Canadians don't do it as much. We don't have as much trapped methane in our sea ice.

Claire: [inaudible 86:05]

Victoria: [inaudible 86:39]

[applause]

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