Q&A: Heather H. Quilenderino, Director, U.S. National Ice Center and Commander, U.S. Naval Ice Center

From left: Cmdr. Heather H. Quilenderino, director of the U.S. National Ice Center (USNIC), Cmdr. Ruth Lane, former USNIC commanding officer, Cmdr. Kristen Serumgard, U.S. Coast Guard, and John Parker. Quilenderino, Serumgard and Parker are co-directors of the North American Ice Service. *U.S. NATIONAL ICE SERVICE*

Cmdr. Heather H. Quilenderino is the director, U.S. National Ice Center, and commander, U.S. Naval Ice Center.

She qualified as a surface warfare officer on a guided-missile cruiser before laterally transferring to the naval oceanography community. She graduated from the Massachusetts Institute of Technology/Woods Hole Oceanographic Institution joint program in oceanography, earning a Master of Science in oceanographic engineering, and earned her Ph.D. in meteorology from the Naval Postgraduate School.

She served as staff oceanographer for Naval Special Warfare Group 10, and for commander, Carrier Strike Group 10. Prior to assuming command of the Naval Ice Center, she served as the Operations Officer, Fleet Weather Center Norfolk. In 2016, she was awarded the Oceanographer of the Navy Commander Mary Sears Award.

Quilenderino discussed the operations of the National Ice Center with Senior Richard. R. Burgess. Excerpts follow:

What is the mission of the U. S. National Ice Center and the Naval Ice Center? What is the difference between the two?

QUILENDERINO: There is a slight difference, but we do have a mission that is one and the same, and our mission is to provide global-to-tactical scale snow and ice products, ice forecasting, and other environmental intelligence services to the U.S. government. The U.S. National Ice Center [USNIC] is made up of three agency components, so the Naval Ice Center [NIC] is the core component and the largest – the contribution from the U.S. Navy – and we are our own command. And so, I serve as the commanding officer of the Naval Ice Center as well as the director of the U.S. National Ice Center.

Our NOAA [National Oceanic and Atmospheric Administration] component is the Ice Services Branch of the Ocean Prediction Center, which is under National Weather Service, our newest realignment in May 2020. We also have a small Coast Guard component, which aligns under the Office of Waterways and Ocean Policy at Coast Guard Headquarters.

How is the USNIC funded?

QUILENDERINO: It's a combination of funding from the Defense, Commerce and Homeland Security departments. This year [2021], our budget is approximately $13 million.

What types of analysis or mapping does the USNIC do?

QUILENDERINO: We don't necessarily do ice mapping, but we do ice analysis, and I use that distinction between because, particularly, in my mind, ice mapping would be more of something that you would do when you are actively in reconnaissance mode. In general, our day-to-day analysis is a wider area analysis that we then fine-tune to a higher resolution. We do that with, really, any data that are available, because the Arctic is a very data-sparse region. We are looking for anything from satellite data to buoys and models, anything that's available within the region that can provide us with information on the ice conditions, with satellites being our primary, models being our additional

input and then, if buoys are available in our region of interest, we use them to validate the overhead sensing to provide additional information.

We do have some specific examples of ice mapping. What comes to mind is ICEX [Ice Exercise] conducted by the Arctic Submarine Lab [ASL]. When they are selecting the ice floe for the ice camp for that exercise every two years, they do aerial reconnaissance flights to select the floe generally with our analysts on board. We send one of our analysts as well as one of our Navy lieutenants, who leads the mobile environmental team, and they will be part of the pioneering flights to locate potential floes. The pilots will conduct the virgin landings on the floes and do coring samples or tow a sled to do more rigorously map the ice to get the conditions. These are collaborative projects that we do with University of Fairbanks. These are things that we will add in with our partners when doing specific mission operations like that with ASL that we wouldn't normally do.

What sensors and platforms does the USNIC use for ice data?

QUILENDERINO: Of our newest, exciting tools, one is operational, and one is still in development. The Earth System Prediction Capability is a new operational ensemble at FNMOC [Fleet Numerical Meteorology and Oceanography Center] in Monterey, California. It provides us with a 45-day ensemble of sea ice forecasts and is the first medium-range ensemble forecast that we have for sea ice. We began testing it two years ago with the Naval Research Lab, and it has shown extremely positive results in several of our tailored missions, as well as ICEX 2020 in predicting long-term location and concentration of sea ice and multi-year ice.

The second project that we are working on in collaboration with NGA [National Geospatial-Intelligence Agency] Research Division is called Snowfox. It's an AI/ML [artificial intelligence/machine learning] project where they're working

on an automated sea ice classification algorithm to help us manage the large quantity of synthetic aperture radar imagery that's coming in from satellites. It will be able to automate some of the routine ice analysis that we do, so that our analysts can focus on areas where tailored mission support is going on. So, we provide one of our master ice analysts with their skills set to the project in collaboration with NGA, and that has shown some exciting results. We look forward to bringing that into operations in the next two years at the USNIC.

Does USNIC have dedicated satellites, or does it piggyback on those of other agencies?

QUILENDERINO: We don't have dedicated satellites for us and for ice reconnaissance. So, all of the satellite resources we use are usually multipurpose satellites, but, really, any satellite that has visible, IR [infrared], microwave or synthetic aperture radar [SAR] can provide data that will be of use to us in our ice analysis. We use a variety of U.S. and foreign satellites. For example, we use a significant number of NOAA satellites where we're using a multitude of visible, IR and microwave sensors. Our two primary SAR satellites are RadarSat 2 and Sentinel. SAR is our No. 1 choice for ice analysis, because it is an all-weather capability and does not have any daylight requirement as there is with visible, which is very important in the polar regions.

ICESAT-2, a NASA satellite for ice reconnaissance, is more applicable to science and research applications, because it has too much time latency to be applicable for operational use. And, so, we rely on RADARSAT-2, the Canadian satellite and a Sentinel, which is operated by the European Space Agency. We receive data from Sentinel through an agreement where NOAA is able to access that in near-real time.

The Northern View Agreement, which is a U.S./Canadian agreement that we benefit from through NGA, provides a

significant amount of funding for our RADARSAT-2 imagery and supports almost all of the tailored support imagery ordering that we provide to U.S. government customers in the Arctic.

Now, we do not provide tailored support for foreign entities unless they are in cooperation with a U.S. government project. For example, just this past year, the Norwegian vessel Svalbard picked up an ONR [Office of Naval Research] mission to transit the Arctic and retrieve some ONR buoys. This was supposed to be part of the Coast Guard icebreaker Healy's mission and needed to be reassigned after the Healy's casualty last summer, so the Svalbard was assigned on relatively short notice, and we were able to provide direct support to Svalbard because of their support of the ONR mission. And we had a collaboration with the Norwegian Meteorological Office.

Is the USNIC able to draw upon foreign data and observations to some degree?

QUILENDERINO: We do. We have a few critical international partnerships, the first being the North American Ice Service [NAIS], a partnership between the Canadian Ice Service, USNIC and the U.S. Coast Guard. It is a critical partnership both for working through the data-sharing of the new RADARSAT Constellation Mission that will replace RADARSAT-2, but also, we share responsibility with things like the Great Lakes ice season as well. USCG International Ice Patrol is the USCG core member of NAIS, and Canadian Ice Service is the Canadian core member, along with USNIC, [they] share responsibility for the North Atlantic iceberg season. This partnership is incredibly beneficial throughout the Arctic because of our overlapping areas of interest and partnership.

The second partnership is the International Ice Charting Working Group [IICWG], a collaboration of all of the world's ice services in either hemisphere. Our goal is to create a collaborative environment where we can maintain the same standards and training throughout the globe. If you are a

mariner receiving support in one area and you are transiting around the world and need to receive publicly available ice services from another country's ice service, you could be familiar with their products, because we're all meeting the same WMO [World Meteorological Organization] standards. We also are able to develop decision support products for mariners that can be useful regardless of country of origin when we're talking about protecting safety of navigation. So, through IICWG, one way that we are able to leverage this partnership is we actually use their local area expertise for ice analysis in the Baltic Sea region. We use ice analysis from the Finnish Meteorological Institute and the Swedish Meteorological and Hydrological Institute as part of our global analysis, because they are the experts in their area of the world.

Finally, the final partnership I wanted to mention is the International Arctic Buoy Program. This directly ties to foreign observations. There are 12 nations that contribute to the International Arctic Buoy Program, and our goal is to maintain a network of buoys that are reporting throughout the Arctic. All of those buoys contributed through this program are publicly available data that are transmitted over the Global Telecommunications System, and into model data worldwide. So, all atmospheric models from any country can pull this data and use it in their weather models to improve forecasts.

The Seawolf-class fast-attack submarine USS Connecticut (SSN 22) surfaces in the Arctic Circle during Ice Exercise (ICEX) 2020. ICEX 2020 is a biennial submarine exercise which promotes interoperability between allies and partners to maintain operational readiness and regional stability, while improving capabilities to operate in the Arctic environment. *U.S. NAVY / Mike Demello*

What agencies are your customers?

QUILENDERINO: Primarily the Navy. Our No. 1 Navy customer always has been and still is the submarine force as they have been in the Arctic for decades. We continue to support them on a daily basis. We have seen an increase in naval surface forces requesting our support primarily through individual ships that are doing high-north deployments. In the past few years, we've seen a significant increase in support of planning products for Fleet, OPNAV [Office of the Chief of Naval Operations] and SECNAV [Secretary of the Navy] staffs.

On the NOAA side, we do provide tailored support to NOAA ships in their research missions to include things like fisheries missions, some of their autonomous vehicle operations, and their weather forecasting offices in areas where sea and lake ice can impact the local communities. And this linkage was also one of the reasons for the realignment to National Weather Service within NOAA in 2020.

For the Coast Guard, we directly support icebreakers and any other Coast Guard ships that are in or near ice-infested waters and we provide support to various Coast Guard staffs.

So, any U.S. government entity or government-funded entity can request tailored support. For example, an ONR- or NSF [National Science Foundation]-funded scientific mission may reach out and request tailored support from us. And then, as part of NOAA's weather-ready nation, much of what we do is on our publicly available website, which is also a mobile enhanced site to make it easy for some of our low-bandwidth customers to be able to access that data as they need it.

How do your customers get access to your products?

QUILENDERINO: The majority is through the website. We also use the Navy's CTG [Commander Task Group] 80.7 portals on the various Navy networks, as well as standard Navy message traffic, email for some of our shipboard customers because then we can tailor products down to meet the bandwidth

requirements that they may have. So, you have a single JPEG or very, very small bandwidth or even a text ice bulletin if that's what they need. And we can also provide just a simple overlay that they can bring into Google Earth or their navigation system or any sort of GIS-enabled visualization system.

The Arctic has been a focus of attention with the thinning and the melting of the icecap. Has that increased demand for your services?

QUILENDERINO: It certainly has. Over the past three to four years we've seen over a 20% increase annually in the number of products that have been requested, particularly our tailored support products and especially our climatology and long-range planning products.

One of the things that we have found is that, as we've seen the changes in sea ice, that the 30-year climatology is not providing an accurate planning assessment for long-range planning from an operational standpoint because of the significant changes.

We have a product that we call our Trivariate Climatology, which is available on our website. It's a simple product that provides open water, the marginal ice zone and pack ice from 2007 to present, so a more recent two-week averaged time period over those years. We think that it provides a more accurate assessment when it comes to operational planning than looking at a 30-year record that begins in 1980, due to the more recent changes that we've seen in sea ice extent in particular. We're also looking into updating climatology so that we can provide the best planning products for our operational planners.

What has been the most dramatic change in ice coverage that you've observed?

QUILENDERINO: 2020 was the second lowest year on record in the

satellite record for minimum sea ice extent during the summer melt season, and during the summer of 2020 we provided a weekly analysis of all the Arctic Sea routes. Normally we provide this for the Northern Sea Route and the Northwest Passage. What most people will refer to as the Transpolar Route is not included in these products because it is generally ice covered. So, for the first time ever, we actually published a product that included all three routes as open. And we produced this product four times between the Sept. 4 and Oct. 2, when all three routes were open. That was very significant from our perspective.

The second is from Project MOASiC, when the [German] icebreaker Polar Stern wintered over in the pack ice for the yearlong project. We did not have anybody on board but we were supporting MOSAiC from our watch floor. They were expecting to see significantly thicker multi-year ice than they found. This is a rather anecdotal example, but I think that this is the other significant change that we've seen. Most people focus on the decrease in extent of sea ice, but the thickness of the multi-year ice is also rapidly decreasing which is, of course, decreasing the overall volume of ice in the Arctic and will have implications as we continue to see a reduction in sea ice.

The third thing is the thinner first-year ice that has formed over the winter and is more susceptible to easy breakup and melt faster as the melt season begins. What I have seen in just my short time as director is that we've seen these very significant fast breakup events in areas where we haven't necessarily seen them before. Strong storms may come through either early in the melt season or very late in the melt season and cause a significant change in the amount of sea ice simply because that sea ice along the edge of the extent is very fragile. And so, it's very easy to break it up and cause a large significant change in a rapid period of time. My analysts observe that these significant events are happening

more frequently.

In addition to support of ICEX, what are some other examples of operations the USNIC supports?

QUILENDERINO: The Coast Guard icebreaker Healy is planning their Northwest Passage transit for this upcoming summer – both their primary and secondary routes – off of our planning products and the expected ice conditions. NOAA recently had a Saildrone mission to map the north slope of Alaska, which was the first time full North Slope operations were mapped with autonomous vehicles. Using our products, they were able to safely navigate all the way to the Canadian border and back avoiding all ice and ensuring their vehicles were safe.

And finally, we impact operations by enabling things like fuel- and time-savings when we are able to provide a "easier ice channel" when the [Coast Guard heavy icebreaker] Polar Star is breaking and maintaining an ice channel down at McMurdo Sound in Antarctica for the annual resupply mission called Operation Deep Freeze. We know that they're going to break the ice channel to get the ships in. If we can find a channel through first-year ice versus multi-year ice, there is a significant fuel, time and, obviously, cost savings to the Coast Guard and to the U.S. government to be able to break and maintain that channel while they conduct their resupply.