The High Arctic Research Center Concept: Year-Round, Multi-Domain Access for Research, Development and Domain Awareness in the North American Arctic

Peter Davies, Global Fellow, Wilson Center Polar Institute
Sherri Goodman, Senior Fellow, Wilson Center Polar Institute

Rapidly accelerating change in the Arctic brings a complex mix of impact, opportunity and challenge. Year-round, multi-domain access for science is required to provide the observations, measurements and analysis required to build effective predictive, decision-informing models. Year-round, multi-domain access for emergency response and national security is required to develop and test Arctic hardened technologies, enable robust domain awareness and facilitate Arctic operational experience. The proposed High Arctic Research Center (HARC) has the potential to provide year-round, cost-effective access to atmosphere, ocean and coastal environments for both scientific and national security research, development and technology testing. Coordination and collaboration across North American Arctic research and development infrastructure has significant potential scientific and security leveraging value. The HARC has a potentially important role as a cooperative Arctic research infrastructure hub within this North American Arctic research and development collaborative. This cooperative infrastructure network also has the potential to play a contributing role to informing policy dialogues and planning for the North American Arctic. The following paper explores each of these topics in more detail.

Rapidly Accelerating Change in the Arctic

The Arctic is undergoing major, accelerating change and this change brings a complex mix of impact, opportunity and challenges. Multiple recent studies highlight the multifaceted character of this rapidly changing environment. The 2018 NOAA Arctic Report Card reports that surface temperatures continue to warm at twice the rate of the rest of the globe (National Oceanic and Atmospheric Administration, 2018). The twelve lowest years of sea ice coverage have all occurred in the past twelve years. In the Bering Sea region, ocean primary productivity levels in 2018 were sometimes 500 percent higher than normal levels.

The 2017 Sea, Water, Ice and Permafrost in the Arctic (SWIPA) report from the Arctic Council Arctic Monitoring and Assessment Program (AMAP) working group and other research and policy organizations highlight the fact that Arctic changes will continue through at least mid-century, due to warming already locked into the climate system (Arctic Council, 2017). The AMAP report emphasizes that effective mitigation and adaptation policies require a solid understanding of Arctic climate change, in particular improving predictions of the timing of future Arctic changes.

Accelerating Arctic change will have complex and interconnected impacts in multiple areas (National Science & Technology Council, 2016; United States Arctic Research Commission, 2019). Coastal communities are experiencing permafrost thaw, accelerated coastal erosion and rapidly diminishing access to traditional food sources (Gibbs and Richmond, 2015). Energy infrastructure, surface and marine transportation systems are impacted by rapidly changing conditions (Arctic Council, 2009). The opening Arctic ocean is attracting significant US and international interest and activities focusing on new access to significant natural resources (National Petroleum Council, 2015; Rosen and Thuringer, 2017; Brigham, 2014). The opening Arctic also brings new and significantly more complex national security, safety and emergency response challenges (Department of Defense, 2019A; Department of Defense, 2019B; United States Navy, 2019; United States Coast Guard, 2019).

Year-Round Access to Multiple Arctic Domains for Science

Given the scale, complexity and multidimensional impacts of Arctic change, cost-effective, year-round access to multiple Arctic domains for research, development, technology testing and domain awareness is important.

Recognizing this importance, the National Science Foundation (NSF) has created and is currently implementing a major new initiative -- Navigating the New Arctic (National Science Foundation, 2019). The National Science Foundation highlights the fact that current Arctic observations are sparse and inadequate for enabling discovery and simulation of the processes underlying Arctic system change, and are insufficient to assess the impacts of this change on the broader earth system. NSF proposes to establish an observing network of mobile and fixed platforms and tools across the Arctic to document rapid biological, physical, chemical and social changes, leveraging participation by other federal agencies.

Navigating the New Arctic has three goals: 1) improved understanding of Arctic change and its local and global effects to capitalize on innovative and optimized observation infrastructure, 2) advances in understanding of fundamental processes, and 3) new approaches to modeling interactions among the natural environment, built environment and social systems. The Navigating the New Arctic initiative seeks to facilitate development of new enhanced research communities that are diverse and integrative. These communities will be well positioned to carry out effective research at the intersections of Arctic natural and built environments, as well as social systems. Research outcomes are intended to inform U.S. national security and economic development needs and enable resilient, sustainable Arctic communities.

The climatology of the Arctic is changing (National Oceanic and Atmospheric Administration 2011, 2014). With more open water, storms are behaving differently. Storms no longer die in the Arctic, but actually regenerate in Arctic waters because their warming allows storms to gain energy. Moving ice-water boundaries drive further complexities, modulating the flow of energy, moisture and other dynamics. These changes have impacts well beyond the Arctic as well.

The recently launched Mosaic expedition will focus on these dynamics for a full annual cycle in the central Arctic Ocean (Mosaic, 2016). This expedition will make detailed observations on seasonally varying energy sources, mixing processes and interfacial fluxes. Measurements will be made on the processes contributing to the formation, properties and behaviors of Arctic clouds. Mosaic will deploy an extensive set of measurements extending from the atmosphere, through the sea ice and into the ocean, providing important data, through an entire annual cycle. This data will be used to refine understanding and modeling of key climatic processes.

Developing complementary, year-round measurements and observations in the Beaufort and Chukchi Seas would have considerable benefit to United States and Canadian research to understand and develop robust predictive models for this region of the Arctic. While extended summer observations are reasonably well developed, there is currently no research infrastructure that can support developing and maintaining multi-domain observations on a year-round basis and over the multi-year time periods during which fundamental conditions and dynamics will continue to change.

Year-Round Access to Multiple Arctic Domains for National Security and Emergency Response

National security and emergency response communities also recognize major challenges associated with the changing Arctic. In the recently released 2019 Arctic Strategic Outlook, the US Coast Guard references its core mission: "to provide physical presence, at will, to uphold sovereignty, carry out operational missions, promote freedom of navigation, and fulfill other national and international obligations. To operate successfully in the Arctic, the Coast Guard must establish and maintain situational awareness and understanding across the region." (United States Coast Guard, 2019)

The National Strategy for the Arctic Region Implementation Framework assigns responsibility for the Nation's Arctic awareness to the Coast Guard, which includes: information regarding national defense and security; pollution detection and tracking capabilities; weather and environmental observations, including ice reconnaissance; and assessment of human activity and infrastructure (Executive Office of the President, 2016). In order to accomplish these missions, the Coast Guard will focus on improving data collection, including support for the development of collection requirements for Arctic marine conditions, climate, maritime activity, and threats. The ultimate core mission of the Coast Guard is converting this information into actionable and reliable knowledge that can be distributed to all appropriate stakeholders.

The Department of Defense (DoD) and a broad cross section of national security agencies also recognize the growing importance and impact of Arctic change (Department of Defense, 2019A, 2019B; United States Navy, 2019; United States Coast Guard, 2019). The 2019 DoD Arctic Strategy notes that effective operating in the Arctic requires DoD to make time-sensitive, risk-informed investments to understand and build awareness in the region. The strategy also notes

that the North American Arctic also lacks the relatively robust logistics infrastructure of the European Arctic.

A primary DoD need called out in the 2019 strategy is enabling domain awareness. Specific challenges include robust terrestrial and aerial communications equipment, ruggedized multi-domain sensors, increasing in-situ observations and enhancing environmental modeling. Sensors and equipment must be designed to function in the harsh Arctic weather conditions, which include rapid cycles of freezing and thawing and temperatures below minus 60 degrees Fahrenheit.

The DoD strategy notes that equipment testing must be conducted in realistic Arctic conditions for sufficient periods of time. The Arctic operational environment is made more challenging by multiple factors, including sea ice, ocean currents, wind, water and air temperature, sea spray and icing conditions, highly variable ionospheric densities and seasonally changing daylight durations. DoD intends to invest in improved predictive capabilities for the Arctic regions that will enable more reliable forecasts. Understanding and predicting the physical environment is critical for meeting mission demands and for ensuring the safety of personnel and equipment.

As recognized in both scientific and national security research and development communities, there is a fundamental need to address key science questions to reduce uncertainty in predictive forecasts (both short and long term); to develop, test and field domain awareness technologies; to gather robust observational data sets; and to develop Arctic hardened technology and operational experience. Addressing these research, development and testing challenges requires robust, year-round access to multiple Arctic domains. Given the scale of these challenges in the face of rapidly changing conditions, this access must also be cost effective.

The High Arctic Research Center Concept: Year-Round Arctic Access for Research, Development and Domain Awareness

The proposed High Arctic Research Center (HARC) is an emerging concept that focuses on providing cost effective, year-round, multi-domain access for research, development, Arctic technology testing and domain awareness (Figures 1 and 2) (Hardesty, et al, 2018; Hardesty et al, 2019; LaBelle-Hamer, et al, 2019; Parrott and LaBelle-Hamer, 2019). The proposed HARC site allows research and testing where Arctic conditions and human activities intersect. The Center will include labs for research, testing and technology development, a center for unmanned systems and autonomous platform operations, staff and researcher lodging, operational support infrastructure, and spaces for teaching and training. Road access via the Dalton Highway (trans Alaska pipeline road) to the proposed HARC site at Oliktok Point is a major cost saving asset, connecting the site to sub-Arctic Alaska and the lower 48 states. Digital communications to the site will be greatly enhanced by cross-Arctic and across Alaska broadband fiber-optic cable recently installed at Oliktok Point, which is now fully operational.

Figure 1. HARC location (Hardesty et al, 2019).

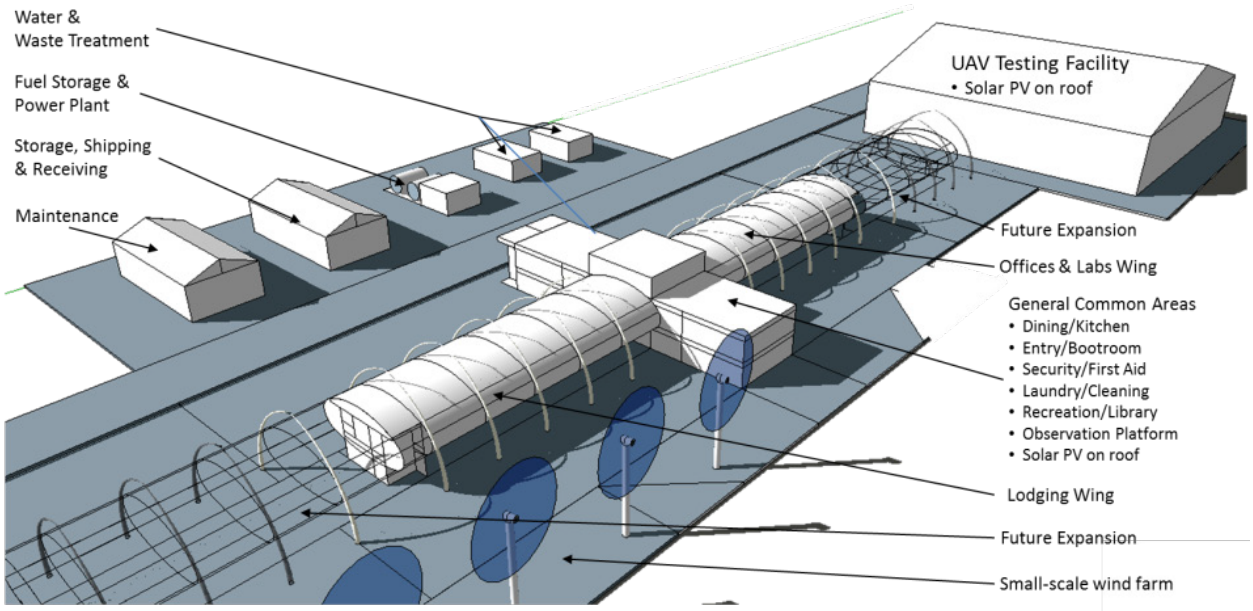

Figure 2. HARC conceptual design (Hardesty et al, 2019).

FAA Restricted and Warning areas at the HARC site provide access to airspace 700 miles northward across the Arctic Ocean toward the North Pole. This FAA airspace, coupled with support for unmanned aerial systems operational support, is a major asset for scientific observation and technology testing (Figure 2). This airspace, coupled with an onsite runway, enable coordinated terrestrial-aerial-marine research by a range of different unmanned aerial system types. Nearby ocean access provides the capability to field complementary surface and subsurface unmanned vehicle operations, enabling complementary observations and measurement in the atmosphere, as well as at and below the ocean and ocean-ice interface.

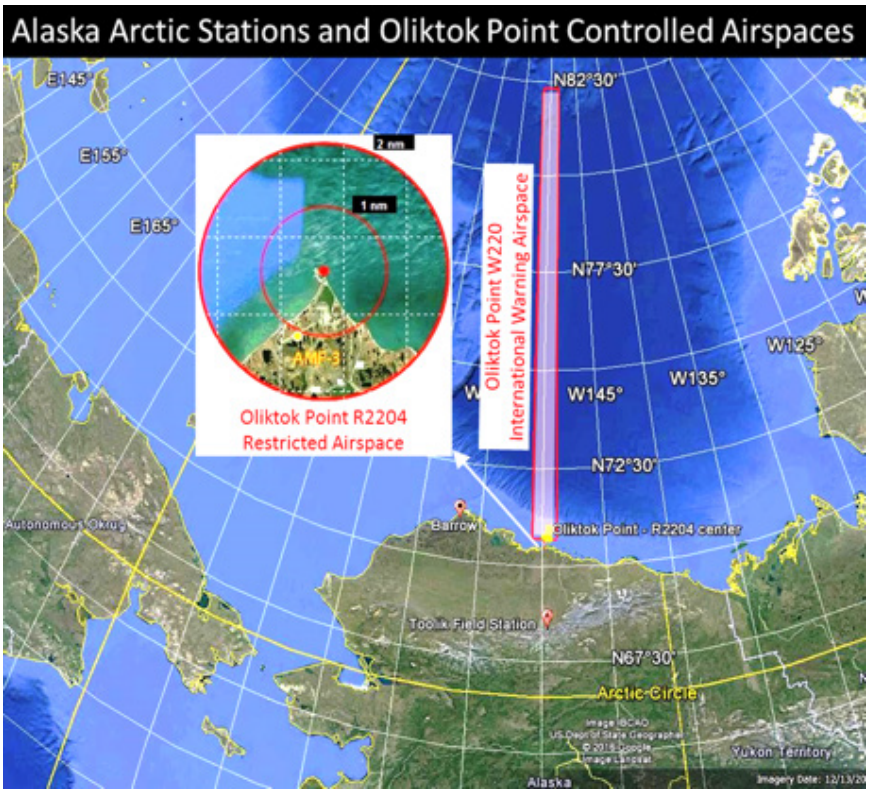

Figure 3. FAA Restricted and Warning areas at HARC provide cross-Arctic access for aerial observations and measurements (Hardesty et al, 2019).

HARC is intended to provide a science platform that will enable complementary, year-round measurements and observations in the Beaufort and Chukchi Seas. This data will enable research to understand and develop robust predictive models for this region of the Arctic. As previously noted, while extended summer observations are reasonably well developed, there is currently no research infrastructure that can support development and maintaining multi-domain observations on a year-round basis and over the multi-year time periods during which fundamental conditions and dynamics will continue to change.

From a national security and emergency response perspective, HARC will enable research, development and technology testing in support of expanding missions. These missions potentially include increased search and rescue needs for ships and personnel; oil spill detection and response; illegal and unregulated fishing; migration and illegal entry into the US; foreign surveillance and intrusion; cyber incursions and other communications disruptions, missile defense; and direct physical and other attacks on the US homeland. Supporting these missions will require research, development and Arctic-condition testing for domain awareness technologies. Success will depend in part on the ability to transition research to operations to meet emerging Arctic national security and emergency response missions.

Partnerships will play a central role in leveraging HARC capabilities. This will require coordination of programs, capabilities, resources and observation systems across research and development communities, indigenous observation networks, emergency response and national security communities. An effective governance structure coordinating across these diverse communities will be very important. From a science perspective, this will potentially include multiple federal agencies (e.g. NSF, NOAA, NASA, DOE) and universities. From a national security and emergency response perspective, this will potentially include a range of national security agencies (e.g. USCG, DoD, Navy, Air Force, Army Corp of Engineers, DHS and the intelligence community). And from an indigenous community and observations network, this will potentially include Native Corporations and coordinated observation networks (Johnson et al, 2014).

Coordination and Collaboration Across North American Arctic Research and Development Infrastructure

As Arctic change and Arctic operations cross national boundaries, research and development to support planning, operations and policy decisions must also cross national boundaries. The Arctic Council is the preeminent forum for global Arctic cooperation. The Arctic Council has provided the framework for establishing three major treaties on scientific cooperation, oil spill preparedness and response, and search and rescue (Arctic Council, 2011; 2013; 2017). HARC fulfills the vision of the Arctic Council agreement on scientific cooperation by providing the physical location and facilities to support coordinated North American Arctic research and development.

The Second Arctic Ministerial held in Berlin in 2018 highlights the fact that "Arctic research can often be difficult and expensive, and it requires the sustained availability of costly research infrastructure to observe, monitor and understand the rapid changes taking place in the Arctic... Costs can be reduced, and outcomes improved, by further promoting the sharing of research infrastructure and observing systems." (Second Arctic Ministerial, 2018A, 2018B)

Multilateral and bilateral cooperation, collaboration and agreements also play an important role in the Arctic. Given shared demographic, geographic, environmental, economic and security interests, cooperation and collaboration across the North American Arctic has significant value.

In addition, both technical cooperation and policy negotiation will be required to address important North American Arctic issues, including negotiation of continental shelf boundaries and effective management of increased maritime traffic across the Beaufort Sea north of Alaska and through the adjacent Northwest Passage (Baker, 2009; Steenson, 2016; Higginbotham and Spence, 2018).

The recently released Canadian Arctic and Northern strategy specifically calls out the value of North American Arctic cooperation. "We will target cooperation with our North American Arctic partners: the United States-Alaska and Kingdom of Denmark-Greenland. Demographic, geographic and socio-economic similarities between the Canadian Arctic and north, Alaska and Greenland provide a strong case for cooperation... Additionally, we will regularize a bilateral dialogue with the United States on Arctic issues as this will strengthen the leadership role both countries take on Arctic issues and enhance the Canada-U.S. bilateral relationship across government and with Northerners." (Government of Canada, 2019A, 2019B, 2019C)

Canada has recently established the Canadian High Arctic Research Station (CHARS), a permanent, multi-mission Arctic research station with year-round access to multiple Arctic domains (Polar Knowledge Canada, 2019). CHARS strategic priorities include providing baseline information to prepared for northern stability, including developing capabilities for predicting the impacts of changing ice, permafrost and snow on shipping, infrastructure and communities. The new Canadian Arctic strategy recognizes the value of international scientific cooperation, and the role the CHARS will play in facilitating that cooperation.

Coordination and collaboration across North American Arctic research and development infrastructure has significant potential scientific and security leveraging value. "International cooperation can help us eliminate gaps in our knowledge of the Arctic and north, particularly given the complexities, interconnectedness and costs related to polar science and research. Canada is well placed to play a central role, given our world-class monitoring and research infrastructure assets and our international reputation for high-quality Arctic knowledge and research... We will also improve the international sharing of scientific data and facilitate the movement of recognized international researchers and equipment within our boundaries. In particular, international scientists will be welcomed to our cutting-edge labs and facilities, including the new Canadian High Arctic Research Station." (Government of Canada, 2019B)

Greenland is also a critical strategic partner in the North American Arctic. Greenland is experiencing some of the most rapid changes on the planet, with major melting of the Greenland ice sheet and associated glaciers, as well as permafrost thaw. With growing public attention to Greenland, now is an important time to reinforce the strategic value of collaborative North American Arctic research.

On September 9th, 2019, the Wilson Center Polar Institute, together with the Government of Greenland, the National Science Foundation, and the Institute of Arctic Studies hosted a program on "Greenland-US Research Cooperation: Exploring a New Model for Research in

Greenland" (Wilson Center, 2019). At this program, Greenland's minister responsible for foreign affairs highlighted the dramatic physical and environmental changes that Greenland is experiencing as the Arctic warms. In addition, she highlighted the active reconfiguration of coordination of international research in Greenland, including the establishment of a new international research hub in Nuuk. This research center will coordinate logistical and administrative services for international science facilities located in Greenland. This center will also facilitate the coordination, collaboration and incorporation of multiple generations of systematic indigenous monitoring and knowledge with research conducted by visiting scientists from the United States, Europe and a number of Asian countries. The minister also highlighted the need for stronger bi-lateral science cooperation with the United States.

A North American framework to enhance cooperation, collaboration and partnership across North American research and development infrastructure would enhance and leverage these facilities. Benefits would include: 1) enabling complementary and synergistic research and resource allocation; 2) facilitating increased knowledge of, and access to, expanded capabilities and facilities; and 3) enabling more efficient information sharing and thus enhanced problem-solving on North American-specific concerns. Given its planned year-round access to multiple Arctic domains and intent to serve research and development from multiple science and national security communities, HARC will be strongly positioned to serve as an important research infrastructure asset in a North American suite of Arctic research stations. Active coordination and collaboration with research programs and infrastructure in Canada and Greenland will be an important component of HARC's Arctic research, development and domain awareness mission.

References

Arctic Council, 2009: Arctic Marine Shipping Assessment 2009 Report

Arctic Council, 2011: Agreement on Cooperation on Aeronautical and Maritime Search and Rescue in the Arctic

Arctic Council, 2013: Agreement on Cooperation on Marine Oil Pollution Preparedness and Response in the Arctic

Arctic Council, 2017: Agreement on Enhancing International Arctic Scientific Cooperation

Arctic Council, AMAP Working Group, 2017: Snow, Water, Ice and Permafrost in the Arctic (SWIPA) - 2017

Baker, B, 2009: Filling an Arctic Gap - Legal and Regulatory Possibilities for Canadian-US Cooperation in the Beaufort Sea, Vermont Law Review, Vol. 34

Brigham, L.W., 2014: Environmental and Economic Security Challenges in a Changing U.S. Marine Arctic, Stanford Hoover Institution, Arctic Security Initiative

Department of Defense, Office of the Under Secretary of Defense for Policy, 2019A: Department of Defense Arctic Strategy, Report to Congress

Department of Defense, Office of the Under Secretary of Defense for Acquisition and Sustainment, 2019B: Report on Effects of a Changing Climate to the Department of Defense, Report to Congress

Executive Office of the President, Arctic Executive Steering Committee, 2016: Appendix A - Implementation Framework for the National Strategy for the Arctic Region

Gibbs, A. and Richmond, B., 2015: National Assessment of Shoreline Change— Historical Shoreline Change Along the North Coast of Alaska, U.S.-Canadian Border to Icy Cape, US Geological Survey Open File Report 2015-1048

Government of Canada, 2019A: Canada's Arctic and Northern Policy Framework

Government of Canada, 2019B: Canada's Arctic and Northern Policy Framework - International Chapter

Government of Canada, 2019C: Canada's Arctic and Northern Policy Framework - Safety, Security, and Defence Chapter

Hardesty, J; Ivey, M; Parrott, L; Bull, D, 2018: USHARC - U.S. High Arctic Research Center, Presentation to the National Academy of Sciences Polar Research Board, October 2018

Hardesty, J; Bull, D; Ivey; M; Dexheimer, D; Helsel, F; Cahill, C; Eicken, H; Roesler, E, 2019: Opportunity to Plan and Develop a Comprehensive US Arctic Research Infrastruce Network Hub at the Prudhoe Bay Area, Global Monitoring Annual Conference, NOAA Earth System Research Laboratory

Higginbotham, J. and Spence, J, 2018: Special Report - The North American Arctic, Energizing Regional Collaboration and Governance.

Johnson, N; Alessa, L; Behe, C; Danielson, F; Gearheard, S; Gofman-Wallingford, V; Kliskey, A; Krummel, E; Lynch; A; Mustonen, T; Pulsifer, P; Svoboda, M, 2014: The Contributions of Community-Based Monitoring and Traditional Knowledge to Arctic Observing Networks: Reflections on the State of the Field

LaBelle-Hamer, N., Ivey, M. and Parrott, L., 2019: High Arctic Research Infrastructure, 8th Symposium on The Impacts of an Ice-Diminishing Arctic on Naval and Maritime Operations, July, 2019

Mosaic, 2016: Science Plan - Multidisciplinary Drifting Observatory for the Study of Arctic Climate

National Oceanic and Atmospheric Administration, 2011: NOAA's Arctic Vision and Strategy

National Oceanic and Atmospheric Administration, 2014: NOAA's Arctic Action Plan, Supporting the National Strategy for the Arctic Region

National Oceanic and Atmospheric Administration, 2018: Arctic Report Card 2018

National Petroleum Council, 2015: Arctic Potential - Realizing the Promise of U.S. Arctic Oil and Gas Resources

National Science and Technology Council, Interagency Arctic Research Policy Committee, 2016: Arctic Research Plan FY2017-FY22

National Science Foundation, 2019: Navigating the New Arctic (NNA), Program Solicitation, NSF 19-511

Parrott, L. and LaBelle-Hamer, N., 2019: US High Arctic Research Center (USHARC) - National Security Breakout Session, 8th Symposium on The Impacts of an Ice-Diminishing Arctic on Naval and Maritime Operations, July, 2019

Polar Knowledge Canada, 2019: Final Draft Science and Technology Plan, 2020-2025

Rosen, M.E. and Thuringer, C.B., 2017: Unconstrained Foreign Direct Investment: An Emerging Challenge to Arctic Security, CNA Analysis and Solutions, Report COP-2017-U-015944

Second Arctic Science Ministerial, 2018A: Joint Statement of Ministers, On the Occasion of the Second Arctic Science Ministerial, October, 2018, Berlin, Federal Republic of Germany.

Second Arctic Science Ministerial, 2018B: Co-operation in Arctic Science - Challenges and Joint Actions, Second Arctic Science Ministerial, October, 2018, Berlin, Federal Republic of Germany.

Steenson, 2016: Mapping the Extended Continental Shelf in the Arctic, Coast Guard Compass

United States Arctic Research Commission, 2019: Report on the Goals and Objectives for Arctic Research 2019-2020.

United States Coast Guard, 2019: Arctic Strategic Outlook

United States Navy, Chief of Naval Operations, 2019: Strategic Outlook for the Arctic

Wilson Center, 2019: Greenland-US Research Cooperation - Exploring a New Model for Research in Greenland, Greenland Dialogues Event, Wilson Center Polar Institute, September 2019