



Prepared by:

Danielle Cherpako, Centre for Defence and Security Studies' Student Fellow

Nicholas Glesby, Centre for Defence and Security Studies' Student Fellow

Andrea Charron, Director, Centre for Defence and Security Studies

### **Virtual JABAS - Joint Agile Basing Airpower Seminar 22 September 2020**

**Goal of the JABAS Series** – the goal of JABAS, also known as Arctic Airpower Seminars, is to exchange ideas, practical applications, and build relationships that enhance airpower projection and domain awareness in the high north. The quarterly series sits between the strategic and tactical levels, examining operational-level challenges associated with agile basing. Each seminar is dedicated to a deep investigation of a specific element associated with planning, executing and sustaining agile basing solutions in a rapidly changing environment. One key difference between JABAS and other defense fora is that defense and security objectives are viewed through an integrated lens that considers non-defense factors, such as the concerns of indigenous communities, climate science realities, and commercial/economic development.

As more world-wide attention turns to the Arctic, more vessel and aircraft traffic is expected. At the same time, climate change means that more requests for assistance in the Arctic by various levels of government will be made of both the U.S. and Canadian militaries. With these considerations in addition to the background great power competition in which NORAD seeks to project joint airpower into the Arctic, **the Canadian and U.S. militaries need agile (moveable) bases/operating locations and the right equipment and personnel need to be in the right place at the right time.** Current bases and forward operating locations may not be optimally

located. Multiple and changing forward operating locations (FOLs) may be required and with them, particular communication needs.

**The aim:** Bi-lateral seminar series at the action officer lever (O6 or equivalent) on enabling agile all-domain, Northern basing operations. Participants currently include Canadian NORAD Region (CANR) Members, U.S Soldiers, Airmen, CJOC, SJS, JTF-North, and Extreme Cold Industry Innovators, and related stakeholders focus on innovation and proposing multi-domain solutions for projecting joint airpower in an extreme cold environment.

This seminar concentrated on hearing from new voices, especially indigenous leaders, airpower practitioners, academics, engineers, and scientists to understand their perspectives on the challenges and possibilities associated with agile basing.

<b>Theme</b>	<b>Presenter</b>
Introductions	Brigadier General Vaughan, Deputy-Commander CANR and Dr. Andrea Charron, Director Centre for Defence and Security Studies
NATO view of the Arctic	Adam RUTHERFORD LTC (OF-4), GBR Royal Marines Analyst (Strategic Foresight Analysis) Strategic Plans and Policy Directorate Supreme Allied Commander Transformation
Inuit Perspective and Obligations given UNDRIP	Dr. Dalee Sambo Dorough Chair , Inuit Circumpolar Council
U.S. Perspective on Arctic basing needs	Ms. Iris Ferguson (USAF) Senior Advisor and Canadian Council on Foreign Relations Fellow
Cdn Perspective on Arctic basing Needs	Mr. Paul Comeau S&T Director, Defence of North America Defence Research and Development Canada / Government of Canada
Nanosatellites for communities and the military	Dr. Philip Ferguson Canada's NSERC / Magellan Aerospace Industrial Research Chair in Satellite Engineering University of Manitoba
AIS location technology	Mr. Daniel Taukie Nunavut Tunngavik Incorporated
Wrap up and hot wash	General Vaughan and Dr. Andrea Charron

**Brig Gen. Edward Vaughan:**

Deputy Commander, Canadian North American Aerospace Defense Region, and Deputy Joint Force Air Component Commander for 1 Canadian Air Division, Winnipeg

Our goal today is to hear solutions and to build relationships. There are lots of stakeholders involved in this project. In Canada, it is gender equality week. The Prime Minister has released a statement affirming the importance of gender identity and gender expression. Why does this matter for our seminar today? As we move forward, as we view and talk about the north, we cannot approach this as we have traditionally. We have to consider the perspectives of Indigenous peoples, the gendered impact of activities in the north, and the importance of climate science. Traveling around the Arctic, one notes the old Cold War airways and military sites, and one realizes that many of these sites, built for national security and defence purposes, were also built without regard for the Indigenous peoples living in these areas. We need to consider what we have done well and what things we have done not so well. One success to highlight: the work of the international science community in Antarctica. There has been significant cooperation in this area. While the Arctic is certainly different, the takeaway from both is the need for a spirit of cooperation. We also need to look at solutions that benefit communities, the economic stakeholders, and additionally, [what makes sense given defence and security considerations](#).

**Dr. Andrea Charron:**

Director, Centre for Defence and Security Studies  
University of Manitoba

Thank you to everyone, and especially to the presenters for taking the time to share their expertise with us. There are numerous reasons why [this a propitious time](#) to prepare for a new way of thinking about agile basing in the Arctic. We have the concurrence of climate change, great power politics, and now Covid-19. We need to think both strategically and tactically, but not in isolation of other actors and allies in decision-making processes. I am honoured to be co-hosting this event and look forward to the presentations to follow.

**NATO view of the Arctic: Adam Rutherford**

LTC (OF-4), GBR Royal Marines  
Analyst (Strategic Foresight Analysis)  
Strategic Plans and Policy Directorate  
Supreme Allied Commander Transformation

*Key takeaways:*

- *[NATO tracks megatrends 20 years outward](#), following the logic that we must remain 4-5 planning cycles ahead of possible trends. They consider possible changes to trends and watch indicators of change to prevent 'strategic shocks.' Some shocks occur anyway, even when generally prepared. (e.g. Covid-19)*
- *NATO never used to talk about the Arctic, because this was largely in the domain of Arctic states only. Now, within the alliance, there is a growing interest, and some states have developed their own Arctic policy papers/strategies.*

- *Themes of importance include: a) the pace of climate change, b) the level of trade that is rising, as well as the amount of shipping. General access as a result of climate change creates various implications, and c) geostrategic competition.*
- *NATO's 2 main threats are Russia and terrorism. China is seen as more of a competitor than a threat, but the relationship between Russia and China is of interest to NATO. Russia may become concerned about China and other states, such as India, becoming more involved in the Arctic. If their involvement in the Arctic does not come with economic or other benefits for Russia, this activity may be seen as encroachment, and may influence how Russia responds to them. (NATO is tracking this)*
- *Russia is expected to continue to undermine the rules-based international order through the use of hybrid tactics in the Arctic.*
- *Two approaches to handling Russia: 1) a deterrent element from Article 5. This comes as a challenge in the Arctic and in the Mediterranean. 2) actively seeking opportunities to create dialogue with Russia. With Russia taking the chairing position of the Arctic Council in 2021, there is significant opportunity for open and steady dialogue.*
- *NATO must enhance bilateral and trilateral relationships, especially where there are currently seams or tensions that Russia might try to exploit. Luckily, there are natural relationships (based on common interests and values) between NATO allies.*

I will aim to set the scene and provide a wider alliance overview. Since I have spent time working inside the Arctic circle, I have both a micro and macro view of the Arctic environment. NATO does not have a formal Arctic policy, so what I am providing is from my own perspective. My approach to this discussion will cover three aspects: 1) The future perspective, 2) Why NATO is looking at the Arctic, and 3) Russia and China. I will then discuss what NATO can do to address these challenges.

1) We primarily track mega-trends going out 20 years from now, and we look at plausible scenarios. We choose 20 years because this includes roughly 5 terms of NATO planning cycles. The idea is that we always need to be looking 4-5 cycles ahead. For the alliance, the centre of gravity is 'cohesion.' We have to think about what might disrupt trends, and what indicators and warnings tell us that things might change. We do this in order to avoid 'strategic shock.' For example, while we had considered pandemic scenarios in our foresight, we still experienced a form of strategic shock.

2) From an Arctic point of view, it is important to recognize that NATO has changed its understanding of the region. It is a big change for NATO to now discuss the Arctic. It used to be a taboo, it used to be Arctic states exclusively talked about the Arctic. Now, there is a rising level of interest within the whole alliance over the past 4-5 years to look at the Arctic more seriously. For example, France and the UK have published big strategy papers focussed on the subject. The Arctic was also formally discussed within the military committee and was tabled as a subject which would require more in- depth and ongoing discussion. There are several themes to look at, including a) the pace of climate change, b) the level of trade that is rising, as well as the amount of shipping. General access as a result of climate change creates various implications, and c) geostrategic competition. Each of these themes has elevated the region to the forefront of international debates.

3) The core threats that NATO faces are from Russia and terrorism. China is not usually talked about by NATO as a ‘threat.’ It is usually discussed as an emerging competitor at all levels (economic, military, etc.). First turning to Russia, it is hard for NATO to understand and adapt to a changing Arctic without understanding Russia’s role at a deeper level. How we approach Russia is extremely important. We have chosen to use a dual- track view so far, which has two approaches: 1) a deterrent element - a robust deterrent which comes from Article 5. This comes as a challenge in the Arctic and in the Mediterranean. This is where naval capabilities are important. 2) actively seeking opportunities to create dialogue with Russia. With Russia taking the chairing position of the Arctic Council in 2021, there is significant opportunity for open and steady dialogue with Russia. However, we still expect Russia to continue with its confrontational approach within the next 5-10 years. We can expect Russia to continue to challenge the rules-based international order as part of its goals of regaining status on the global stage. This involves undermining NATO in the Arctic and using hybrid activities to do this. Ultimately, we are unlikely to see Russia use direct confrontation, but Russia will be opportunistic and exploit any seams, any areas where we are lacking.

The relationship between China and Russia is also considered critical. Their relationship is currently a strategic partnership rather than a natural relationship. There could, in the future, be multiple points of tension or friction. We must consider how Russia will continue to view a rising China, and how this might affect their relationship over time. Russia may also grow wary of other actors such as India, as they become more involved in the Arctic. If their involvement in the Arctic does not come with economic or other benefits for Russia, this activity may be seen as encroachment, and may influence how Russia responds to them.

What can NATO do? It is worth mentioning that the area of operations may massively open up as ice lock disappears as a result of climate change. The speed-time-distance calculus then becomes highly relevant. We have to think about situational awareness, and the amount of physical space to cover. It is an ‘austere’ environment from a military perspective. We have to think about what forces you can pitch in that environment, the type of specialist training required, and the type of technology necessary to assist them. Challenges with communication and technology in Arctic environments will not get any easier, as weather continues to be volatile as a result of climate change. We need the right technological and industrial complexes to outlast Russia and China in this environment, and we need better science and tech to increase situational awareness. We know that Russia has a tendency to exploit seams between NATO allies. In response, NATO must leverage its influence as such a significant organization and must enhance bilateral and trilateral relationships to safeguard these seams. We have to be sure there are no fractures in our alliances. Luckily, there are clearly natural relationships within NATO. Equally, NATO cannot expect all nations outside of the Arctic (non- Arctic states) to be particularly committed to the region. Indeed, for some, their strengths lie elsewhere.

Governance mechanisms are also critical. Anything that undermines the Arctic Council is concerning. For a while, there has been a void of military dialogue and we have somewhat been avoiding it. Yet as there is the expectation that competition is growing, we as an alliance can no longer leave security out of the conversation.

**Inuit Perspective and Obligations given UNDRIP: Dr. Dalee Sambo Dorough**  
Chair, Inuit Circumpolar Council

*Key takeaways:*

- *Indigenous peoples, and particularly Inuit have been organizing themselves to collectively advocate for the Arctic to be made nuclear free and a zone of peace, and to look more seriously at developing Arctic policy since the 1970s.*
- *Arctic Indigenous peoples have a hugely important stake in all aspects of Arctic policy, but particularly that which occurs at the strategic level, or ‘high politics’ level. Increased activity in the Arctic (military or economic), as well as climate change dramatically alter the natural environment, which is threatening to the security of Indigenous culture, food security, and the land and marine life.*
- *We need to think creatively about how to address infrastructure gaps and other threats facing Arctic communities, and this means including Indigenous peoples in all levels of decision- making. We can do this following the rights outlined in UNDRIP, such as:*
- *The rights to self-determination, lands, territories, and resources, free, prior, and informed consent, right to participate in decision making, protection from destruction of their culture, right to security, including food security and cultural security.*
- *There must also be a recognition of the patriotism demonstrated by our people, the number of Inuit involved in the Armed Forces, and as Canadian Rangers. This is about a desire to safeguard Inuit homelands and ways of life.*

We need to think more creatively about the Arctic region and defence and security issues. There are some overarching issues that need to be taken into consideration. My presentation carries the message that these activities will have impacts on Arctic indigenous communities above all else. Currently, we are thinking in the context of high politics. It is important to get the message across that the human rights of all Inuit and Arctic Indigenous peoples are a crucial factor in all discussions.

The Inuit Circumpolar Council was established in 1977, and it was a gathering of all blood relations under a theme of unity. Eben Hopson had the foresight to know that we needed to create coherence and coordination among our peoples in the Arctic region.

This has been and continues to be our traditional homeland. Quote:

“We... live under four of the five flags of the Arctic coast. One of those four flags is badly missed here today (Soviet Union) it is generally agreed that we enjoy certain aboriginal legal rights as Indigenous people of the Arctic. It is important that our governments agree about the status of these rights if they are to be uniformly respected.” (Eben Hopson)

Arctic policy was one of the key objectives of the organization. I find it interesting that now, suddenly, the Arctic is of interest to so many actors, and the Inuit wanted Arctic policy and insisted that we, as Inuit, have a seat at every table. They had the foresight to think of these things. Also, in June of 1977, Inuit delegates adopted a set of resolutions. Resolution 77-11 was a specific call for the Arctic to be used in a peaceful manner, as a nuclear- free zone. In terms of historical context, many things were happening at this time (Cold War) without our consent, knowledge, or involvement. For example, there was the DEW line, there were accidents taking

place in Greenland, to name one example, and we were acutely aware of these issues. We wanted to establish the Arctic as a nuclear-free zone to prevent these things. Again in 1983, because of continuing and emerging threats such as low-level test flights, measures and exercises, and the identification of earth resources such as uranium and lithium, Inuit again voiced concerns that this was happening on their homelands and without their direct involvement.

We have to remember that this was happening not only in the context of defence and security, but also through economic development initiatives. We were trying to carry our ideas forward in a diplomatic way. Inuit diplomats had an opportunity to undertake an audience with Mikhail Gorbachev. We have to think about what could have potentially happened if he were able to carry out his objectives as a leader globally, as well as in the Arctic. In 1987 in his Murmansk speech, he noted the difficulties of the day, and called for the North to be a zone of peace. If we had the opportunity to see him roll out his strategic objectives, we would have a very different dialogue today.

We need to also talk about the [United Nations Declaration on the Rights of Indigenous Peoples](#). In 1982, an exercise began to define and articulate the rights of Indigenous peoples. We participated and brought forward Inuit voices. It was a 25 year process, and we patiently undertook Inuit diplomacy once again. In 2007, UNDRIP was adopted by the General Assembly. This affirmed the right of Indigenous peoples to self-determination, lands, territories, and resources, free, prior, and informed consent, right to participate in decision making, protection from destruction of their culture, right to security, including food security and cultural security. Today, there are many land claims agreements being discussed. I underscore these things because we own land, territory and resources in the Arctic, but we also carry important responsibilities that need to be amplified. I invite everyone to read through this to understand the context of these things. Much of the work that we carried forward to today are a part of these human rights norms.

In the context of Norway and Denmark, there is the Convention on Indigenous and Tribal Peoples 1989 brought forward by the International Labour Organization. This is the only existing international human rights treaty specifically addressing the rights of Indigenous peoples, but it has only been ratified by Norway and Denmark. There is also the American declaration on the rights of Indigenous peoples (2016).

Impacts of climate change are significant, especially for Inuit, who rely on and have a profound relationship with the Arctic environment. This is the key reason why we organized ourselves and united to bring our voices forward—to protect the environment. Now we see even more dramatic changes. There is the disappearance of sea ice and changing ice conditions. People see this as a positive thing (for economic reasons, access, etc.), but it is so important to our way of life, the marine environment, our reliance on marine life, and it has an impact on our cultural security and food security. This creates the opening for increased Arctic shipping, which we know on the surface will be ratcheted up significantly. There will be increased militarization, vessel traffic, and everything that comes with this are threats and pose adverse impacts. The Arctic Council and others thinking in terms of high politics have not fully considered this. These threats continue.



The General Assembly in July of 2018 in Alaska adopted another resolution: “The Utiagvik declaration 2018.” This was also centred around laying the groundwork for negotiations to declare the Arctic a peaceful zone.

All of these activities have impacts on cultural, environmental, food, and Inuit security (overall for our security as distinct Arctic Indigenous peoples). Distinct human rights require attention, and we must consider the impacts of militarization. The knowledge we as Inuit have accumulated about the Arctic can mean that results will be better for everyone if we work together. There must also be a recognition of the patriotism demonstrated by our people, the number of Inuit involved in the Armed Forces, and as Canadian Rangers. This is about a desire to safeguard Inuit homelands and ways of life. We cannot forget the interrelated human rights individually and collectively. We need more dialogue at every level, including at the level of defence and security.



**UN Declaration on the Rights of Indigenous Peoples**  
September 13, 2007 -- United Nations General Assembly

- affirming the right to self-determination
- affirming rights to lands, *territories* and resources
- affirming the right to free, prior and informed consent
- affirming the right to participation in decision-making
- protection from destruction of their culture
- right to security, including food security, cultural security

### **U.S. Perspective on Arctic basing needs: Ms. Iris Ferguson**

Senior Advisor at United States Air Force and Canadian Council on Foreign Relations Fellow

*Key takeaways:*

- *[The Department of the Airforce's new Arctic Strategy](#) outlines 4 key lines of effort, including 1) Domain Vigilance, 2) Power Projection, 3) partners and allies, and 4) prep and training.*
- *In order to develop agility, we need to look at 4 factors: installations, locations, logistics, and human capital.*



- *Installations: difficult for air force because of unique needs surrounding necessary basing footprint like hangers, fuelling, and maintenance. Need to consider waste and water management, operating in cold weather, and communications. Cost is a critical concern, and so is the short amount of time we have to complete construction (usually summer months only).*
- *Locations: We need to consider indigenous peoples as well as environmental concerns. Aerial mapping of ice, permafrost, etc., is a critical component.*
- *Logistics: Technical skills, refuelling in cold weather conditions, and communication.*
- *Human capital: need to be able to operate effectively in small teams for agility and operate in large teams with allies for SAR and disaster relief. Developing a system to be able to search and see who has Arctic expertise/experience, survival skills, etc.*

I will begin by briefly talking about some strategic drivers for National Defense and how the environment has changed. Our current defense strategy speaks to great power competition and the need to change force deployment models. Our current posture dates to the immediate post-Cold War era when we were worried about rogue actors. Our Homeland is now at risk and the bases be relied upon are not as secure. We need to operate in a more dynamic way. We need to look at proactive and scalable options, how we will go about this, the logistics, and supply chain management. When looking at an Arctic lens there is an additional set of concepts, skill sets, and equipment needed.

[The Department of the Airforce’s Arctic strategy](#), which was released in July 2020, does talk about the agile perspective. There are 4 key lines of effort identified: 1) domain vigilance, 2) power projection 3) partners and allies, 4) prep and training.

**DAF Arctic Strategy  
Four Lines of Effort**

**“**  
The Arctic is among the world’s most strategically significant regions – the keystone from which the U.S. Air and Space Forces exercise vigilance.  
**”**

Barbara Barrett  
Secretary of the Air Force

[www.af.mil/Arctic-Strategy](http://www.af.mil/Arctic-Strategy)

**Domain Vigilance**

**Power Projection**

**Allies & Partners**

**Preparation**

UNCLASSIFIED Integrity | Service | Excellence 3

Power projection is critical in the Arctic, we need to be able to project power globally from Alaska. The air base is up there can get to many capitals quicker than from the lower 48. Close to 80% of DoD spending for the Arctic comes from the Air Force as it plays a critical role for Homeland defence and power projection from the region

Partners and allies: They are so important because it is challenging to operate alone, and we have to know that we are not operating in a vacuum. Indigenous communities need to be involved as well. We need to ensure that we recognize the knowledge that they have. We also need to build and deepen cooperation with allies who have immense Arctic operational and strategic experience, such as Canada. [NORAD](#) is a great mechanism for enhancing this cooperation.

Prep and training: We have an incredible responsibility to prepare to adapt and respond quickly, because we are likely to be first on the scene in the case of SAR and disaster response. We have to work with local state and federal partners.

In developing agility for the Arctic region important factors to consider include: installations, locations, logistics, and human capital.

Installations: this is critical, it is our beating heart. We fly in and out of these critical hubs. Creating an agile construct is a challenge because we rely on hangers, fuel requirements, and maintenance. It's arguably harder than when we talk about the needs of the army or navy. We need to look at force provider expeditionary systems, operating in cold weather environments, and water and waste management systems. We are testing new options, including commercial, off-the-shelf options and considering modular components to be able to build quicker with more resiliency. The Arctic environment is very expensive and there are short windows where we can start and end construction projects, and so these concepts are critical to success. There are places where we have utilized these methods in the past, and these older structures are still in use, and very resilient. We also need to learn from other partners for this.

Location: The human consideration is most important, and we need to ensure we consult with Indigenous communities. Exercises impact their way of life. We do a decent job from an Air Force perspective in Alaska, because we have good mechanisms to communicate but can always do better. From an environmental standpoint: we need to consider where can you go, can existing infrastructure and bases be retrofitted? We are also mapping out permafrost and ice and determining the ability to land aircraft. This coming winter and summer, we are testing aerial mapping.

Logistics: There are lots of considerations. At the strategic level: special ops in January 2020 focussed on surveying airfields and refuelling in harsh arctic weather. This is useful training for operating behind enemy lines and also good for training in a harsh strategic environment. Communications is also an area where we need to focus. Can we use nanosatellites or is there possibility for a larger investment in polar communications architecture?

Human capital: being able to operate in small teams is vital. So through [Exercise POLAR FORCE](#) in 2019, we considered how to operate in a small team with different capabilities so that

when deployed, we can operate with proficiency. Training at large is focussed on ability to do SAR and disaster relief, as well as personnel recovery. If there is a disaster or event, can we look in the system and see who has arctic expertise, survival skills and can operate in that environment?

### **Canadian S&T perspective on Arctic Basing Needs: Mr. Paul Comeau**

Director Science and Technology for the Defence of North America at Defence Research and Development Canada (DRDC)

#### *Key takeaways:*

- *From an analytical perspective, and in support of the NORAD Northern Basing Study (NNBS), surveys and analysis have looked at 19 different sites across northern Canada to determine their merits as possible agile bases for use and further investment. Potential basing sites were analyzed along two key metrics: operational effect and viability, the latter of which included logistics, existing infrastructure such as runways, proximity to seaports, weather, and value to local communities (among others). The options were narrowed down based on various trade offs for consideration and consultation.*
- *[Lots of research](#) is being undertaken surrounding Arctic power and energy using science and technology which will also improve agility, especially in the long- term. The challenge is to provide sustainable solutions for arctic infrastructure assets and operations. The approach has been to understand baseline energy needs for each asset. 4 sub- projects:*
  - *1) CFS alert project, investigated alternative power and energy technologies, incl. solar, wind, hydro, deep well geothermal, sea water heat pumps, small nuclear options if safety can be met. Baseline energy metering, energy audits, and recommendations come out to improve efficiency and reduce demand. A project is being implemented by infrastructure and environment organization under a \$62million investment,*
  - *2) Advanced Microgrids towards Arctic Zero Emissions (AMAZE), a three-year project to reduce reliance on fossil fuels, demonstrate hybrid systems, and new power and energy concepts, such as for the North Warning System sites*
  - *3) Advanced sustainable secure energy technologies (ASSET). Focused on Deployable camps, mobile power and energy systems, easily deployable. Remote operations, placement of sensor nodes.*
  - *4) Supporting Canadian Underwater Arctic Sentinel Experiment (CAUSE), as part of all-domain situational awareness program (ADSA), examine power systems for monitoring underwater environment. Sensors are off grid have to monitor, such as floating buoys and seabed arrays, and require power and energy.*
- *Many challenges remain such as system integration, cold weather performance, and year-round unattended operation.*

There are many opportunities for collaboration. I will briefly discuss 3 elements pursued by DRDC, focussing on Arctic basing needs. These will inform future policy and options for northern basing. 1) analytical contribution to NORAD basing study 2) work we did in northern power and energy capabilities 3) ongoing work from the Defence IDEaS Innovation Program.

- 1) We surveyed 19 sites in northern Canada and were looking at them because we want to be able to ramp up operations quickly. We took a 15 year-long perspective for potential infrastructure development. We want to be agile in the future. Need investments for fast deployment. Not necessarily manned or staffed on a long-term basis. Need optimal base location, so we compared 19 locations, based on 2 key factors: 1) operational effect and regional coverage, and 2) viability metric. Looking at airfields, runways, existing support, deep water port options, sealine communication access, gaining access to equipment by ship or sea, local support, weather, force protection, and value to local communities. If we were to establish sites there, what would we have? Analysis has not yet considered full costs. Still lots of work to do. Trade-offs between benefits and logistical advantages. Result: identified a small set of leading site options to be involved in local consultations. Want to build in flexibility, need to think well in advance. Also looked at Canadian bases at 12 o'clock location. Base optimization with NORAD. There is also some work sponsored by CAF, land warfare centre, for humanitarian operations such as rescue missions and evacuation. The whole logistics footprint is of key importance. NORAD northern basing was a binational effort, more work to be done based on agile basing concepts.
- 2) Northern Arctic power and energy work in science and technology. Importance for northern operations and distributed remote sensor networks. Need to be powered on a sustainable basis. Sustainable solutions for Arctic infrastructure, and fossil fuel reductions. Overall approach: to understand each platform and their requirements. Fixed infrastructure assets. North warning sites. Energy monitoring, baseline energy demand, development and use of energy models and technologies to reduce our energy footprint in remote areas. 4 sub-projects 1) CFS alert project, alternative powers, solar, wind, hydro, deep well geothermal, sea water, small nuclear options if safety can be met. Baseline energy metering, energy audits, recommendations coming out will be implemented by infrastructure and environment organization under \$65million, 2) advanced microgrids, reduce reliance on fossil fuels, hybrid systems, try to change power and energy concepts, 3) asset for advanced sustainable secure energy. Deployable camps, mobile power and energy systems, easily deployable. Remote operations, placement of sensor nodes. 4) supporting Canadian underwater experiment, all-domain situational awareness program, monitoring underwater environment. Sensors are off grid have to monitor, floating buoys, provide power and energy. Trying to be mobile as well. Many challenges remain on systems integration, cold weather performance, polar night, reduced number of re-fuelling events. Trying to develop smarter ways, in cooperation with National Research Council and Natural Resources Canada. DND investing significantly.
- 3) [The Defence IDEaS Innovation program](#) has considered multiple Arctic challenges. Three challenges were launched recently. DND has invested over \$11million in these challenges, for innovation research, and is developing and inviting proposals for an innovation network of arctic researchers to be launched in 2020. 3 examples of challenges: 1) rugged wind turbines to reduce reliance on diesel, 2) affordable communications solutions support and command and control 3) human factors solutions, seeking the means to enable human operators to perform tasks in extreme and austere conditions. Lots going on in addressing challenges in the arctic.

When considering the Arctic, a useful concept is the fully burdened cost of energy supply (e.g. 7L of fuel to provide 1L at a power station in CFS Alert).

## NORAD Northern Basing Study

- Bi-national effort under the Combined Joint Planning Team (CJPT), co-let by NORAD and USNORTHCOM.
  - Modelled defence plans from CONPLAN 3310-17
  - Used multi-criteria decision analysis, comparing operational effect and other criteria
  - Applied consensus ranking to short-list options.
- Defined a basing solution as a combination of locations, where each location is a Main Operating Base or a Forward Operating Location.
- Details of the problem and solution are classified.
- NNBS CJPT drafted a Commander's Estimate based on the results of the DRDC work. Commander N/NC delivered to a Memorandum to the Secretary of Defence and Chief of Defence Staff on 6 March 2017.

## NORAD Operation Noble Eagle Zero Base Review

- Focused on base optimization for defence of critical assets based on NORAD CAAL.
- Study focus did not consider Arctic.



0

## DRDC Northern/Arctic Power and Energy Activities (1/4)

- I. Challenge Statement:** To provide sustainable solutions for arctic infrastructure assets and operations for fossil fuel reductions while mainlining or improving operational capability.



### II. Methodology/Approach:

- Understanding each platform and requirements (unmanned surveillance, deployable camps and fixed infrastructure assets e.g. CFS Alert, North Warning System)
- Energy monitoring for baseline energy determination in the context of geography and climate and operational requirements
- Development and utilization of co-simulation energy models technology selection and insertion, what-if scenarios analysis
- Recommendations and implementation



1



## DRDC Northern/Arctic Power and Energy Activities (2/4)

### I. CFS Alert Project

- ❖ Investigate alternative power and energy technologies and strategies for fixed infrastructure
  - Solar, wind, hydro, deep-well geothermal, sea-water heat pumps, nuclear
  - Baseline energy metering and energy audits
  - Identified fuel reductions opportunities of ~268,000L to ~662,000L i.e. 15 to 37 HERC flights annually
  - Recommendations being implemented by ADM(IE) under a \$62M project



### II. Advanced Microgrids towards Arctic Zero Emissions (AMAZE) - new!

- ❖ New three year project started June 1<sup>st</sup>, 2020. Modernize power system for the North Warning System with new technologies – de-risk, enable green procurement practices
- ❖ Demonstration of hybrid system (e.g. fuel cells, renewable, variable speed generators etc.) and micro-grids concepts in austere Arctic environments for the NWS



## DRDC Northern/Arctic Power and Energy Activities (3/4)

### III. Advanced Sustainable Secure Energy Technologies (ASSET)

- ❖ Deployable camps/shelters
- ❖ Includes options analysis and assessment of energy technologies such as alternative energy generation (renewables), energy storage, advanced power management with possible demonstration through collaboration of feasible technologies that offer logistical benefits and cost effective options (emphasis on interoperability with allies).



### IV. Canadian Underwater Arctic Sentinel Experiment (CAUSE)

- ❖ All Domain Situational Awareness Program
- ❖ Development of a power and energy system for extended unmanned operation of underwater acoustic arrays
- ❖ Achieved extended unmanned operation for several months into the polar night





## DRDC Northern/Arctic Power and Energy Activities (4/4)

### Remaining issues to resolve:

- System integration
- Cold temperature performance of technology e.g. energy storage (batteries), thermal energy management
- Year round unmanned operation during the polar night (reduce number re-fuelling events, fuel storage)
- Dynamic, real-time monitoring to the south
- Building envelope issues (smarter ways to design and build?)

### Acknowledgements

- Project Partners: Natural Resources Canada CanmetENERGY and the National Research Council Canada



## IDEaS Innovation Initiatives in Support of Arctic Activity

- Multiple Arctic Challenges have been developed by DND/CAF L1 organizations
- In support of the Arctic, three Challenges have already been launched and dozens of Canadian innovators are already designing solutions. A total of \$11.4M has already been invested in these projects
- A challenge is being developed to establish networks of research on the Arctic as well (to be launched in December 2020)



The Department of National Defence and the Canadian Armed Forces (DND/CAF) are seeking ruggedized wind turbines for the Arctic to reduce the reliance on diesel fuel generated power.



DND/CAF requires a reliable, trusted and affordable communications solution to provide both support and command and control to forces in the Northern regions including the Arctic.



The Department of National Defence (DND) seeks the means to enable human operators to perform tasks in extreme conditions including cold.

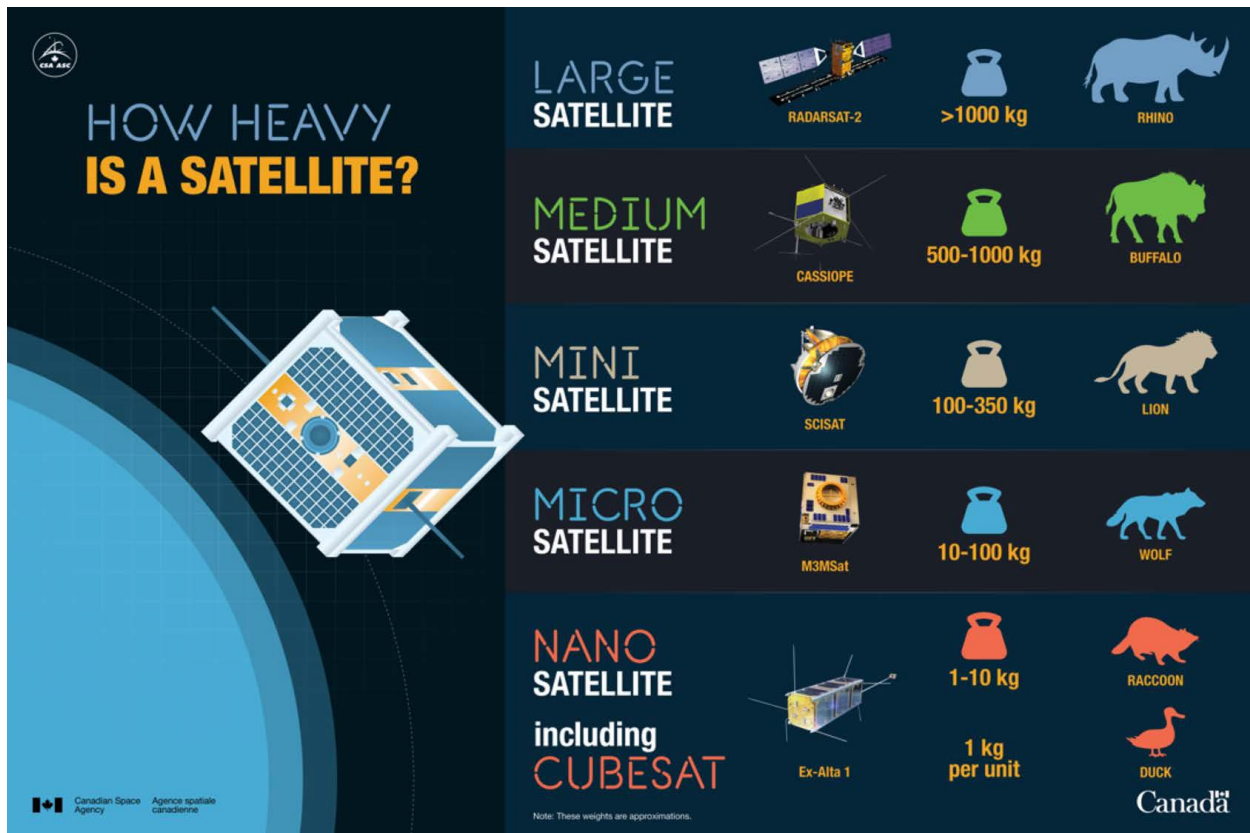
## **Nanosatellites for communities and the military: Dr. Philip Ferguson**

NSERC/ Magellan Aerospace Industrial Research Chair in Satellite Engineering, University of Manitoba

### *Key takeaways:*

- *Nanosatellites are a new and emerging technology which can be considered 'multi-use.' They have potential to benefit both communities and the military in the Arctic context.*
- *Now that we are seeing the benefits of 'agility,' it may be beneficial to use smaller satellites that can be used for shorter periods of time, and that can be more quickly replaced by newer technologies at a cheaper cost, with then less fear about wasting time/money/resources.*
- *Key aspects of a CubeSat: high science return, commercial parts, low mass, usually no propulsion, short missions, frequent contact, technology demonstration, low power, inexpensive.*
- *Use cases: space science, communications, data relay, exploration, remote sensing, education, technology demonstration, outreach, and astronomy.*
- *Key points: responsive, inexpensive, collaborative, educational, engaging, flexible, disposable, powerful, agile, low-cost, accessible, and relevant.*

Nanosatellites can be used for both empowering communities and for military purposes. My research focuses on ways to leverage new technologies to empower researchers and communities. I spent 10 years working in Canadian and international satellite industries, and we talked a great deal about how there are many people who could benefit from this technology but cannot afford it. We thought we would need years to design and implement this technology in a way that could be beneficial to communities. However, in today's world we have much greater access to space and we are in a good position to embrace this technology in a way that could benefit northern communities.



The nanosatellites that we are talking about are the size of a raccoon or a duck, they are between 10 and 30 centimeters long and weigh around 5 kilograms. A CubeSat is a type of nanosatellite. It is essentially a cube that we can put it together in any configuration which allows people to think about spacecraft in a modular way. When these were first created at Stanford University, they were considered toy satellites, and we were not doing much with them in terms of real-world application. Since then, there has been an explosion in the number of small electronics used in space, and we now see companies using these as platforms for running a business. The CubeSat has moved from being considered a ‘toy’ to something that is useful for communities, and, as I said, potentially the military.

Design cycles:

1) We start off thinking about the use of new technologies in space in a ‘vicious cycle.’ We fear the failure of a mission test, so we test and verify more. Then mission costs increase, and therefore the quantity of missions decrease. Then we start all over again with a fear of failure.

2) Instead, we can move towards a more virtuous cycle, which begins with an acceptance of shorter missions. We can test and verify smarter which reduces mission costs. This then increases the quantity of missions we are able to undertake, and we go back to accepting shorter missions, etc.

We have then moved from being scared of the space industry, to now the more virtuous cycle as described above. We can use smaller satellites, which perhaps do not last many years. However,

maybe in today's world we like the idea of agility. We appreciate the ability to communicate and check in with the device more often, so we are okay with not having technology lasting many years. In fact, we are then able to send out newer technology to replace the older nanosatellites, given that costs are cheaper. We want, after all, to be more agile and more responsive.

There are some key aspects of a CubeSat to note: high science return (lots to learn), commercial parts, low mass, usually no propulsion, short missions, frequent contact, technology demonstration, low power, inexpensive.

There are also many ways in which the technology can be used: space science, communications, data relay, remote sensing, education, technology demonstration, outreach, and astronomy. We have also used them for exploration, for example, along with the last Mars mission to record information.

The Canadian government has really taken notice of the CubeSat and its benefits. The Canadian space agency, in 2017 funded these projects for all provinces and territories. The purpose of the [Manitoba CubeSat](#): we work with NASA with [OSIRIS-REx](#).



The screenshot shows the Canadian Space Agency website. At the top, there is a navigation bar with the Canadian flag, the text 'Government of Canada / Gouvernement du Canada', and links for 'Canada.ca', 'Services', 'Departments', and 'Français'. Below this is the 'Canadian Space Agency' header with a red maple leaf logo and the 'Canada' logo. A search bar is visible on the right. A menu bar contains 'Audiences', 'Activities sectors', 'Resources', 'Useful links', 'Multimedia', and 'Activities'. The main content area has a breadcrumb trail: 'Home → Satellites → Cubesat'. The title of the page is 'What is the Canadian CubeSat Project'. Below the title is a large image of a CubeSat satellite in space, with the word 'CUBESAT' written in large blue letters above it. Below the image is a paragraph of text: 'The Canadian CubeSat Project (CCP) was announced in April 2017. The CCP is providing professors in post-secondary institutions with an opportunity to engage their students in a real space mission. Through this national initiative, winning teams of professors and students are offered the unique opportunity to design and build their own miniature satellite called a [CubeSat](#).'

In terms of the scientific payload and educational aspects, here is an example. We have a stick (a gnomon) which serves as a sundial in space on the CubeSat. In working with an elementary school, the students created the design which gets them excited about space and allows them to learn. In this case, we're looking at shadows in space and how trigonometry works. This can also be used for communications. Ultimately, the sky is the limit.

Importantly, the CubeSat costs less than \$200,000, and most of this money actually goes toward the salaries of graduate students. The price of hardware is \$75,000. We have removed a massive mystical barrier, because we are not using classified encryption, making this truly accessible tech. We are now lining up other research projects especially with the northern communities. The launch cost means that there is a prevalence of more commercial access. However, smaller projects can attach nanosatellites to other ‘popular routes’ taken by other companies. This is sometimes called ‘ride sharing’ and allows individuals to get use out of nanosatellites at a lower cost to themselves.

For example, a polar launch from North America occurred recently, launched out of Florida. This does not happen very often, but we are seeing a shift to more interest in polar launch capabilities by companies. This is helpful, as we can do more ride shares, and can start using nanosatellites to empower northern communities specifically.

Key points about nanosatellites to take away: responsive, inexpensive, collaborative, educational, engaging, flexible, disposable, powerful, agile, low-cost, accessible, and relevant.

**AIS location technology: Mr. Daniel Taukie**  
Nunavut Tunngavik Incorporated

Mr. Taukie was originally on the program but because of technical issue, we have rescheduled his presentation. Please watch <https://www.naadsn.ca/events/> for details on the timing.

Please visit the NTI: <https://www.tunngavik.com/>

Inuit Marine Monitoring Program 2020, processes for implementing an ecosystem approach to management of shipping, tourism, and exploration for the Nunavut region.

### **Final comments from presenters**

**Lt Col. Adam Rutherford:** Agility is great, but we need logistics to back it up and even more-so in the Arctic. Sometimes government and military leaders lose perspective of this.

**Dr. Dalee Dorrough:** I found it interesting that there was the original reference to the Arctic as an ‘austere’ environment. There was lots of talk about infrastructure, and in the pandemic too, this is so important. It makes me think of the real potential for dual- use or multi-use materials. There are creative ways to close infrastructure gaps for Arctic communities. I loved the CubeSat discussion, and hearing about the potential for education, research, and monitoring. Finally, Inuit have so much knowledge, so much more that could be done in terms of challenges we face, and on the basis of accumulated knowledge. Might there be a way to conduct research and monitor new tech or explore things in a way that isn’t so “high stakes?”

**Mr. Paul Comeau:** I will highlight again the logistics challenges related to power and energy that are significant. For example, it takes 7 litres of fuel to deliver 1 litre of fuel to be used. Looking at science and tech solutions to reduce reliance on diesel, to avoid spills, the production of black carbon, greenhouse gases. Need to work harder and smarter for sustainability and mobility reasons. I appreciate comments about operating out of small runways and understanding soil composition. Collaboration is highly welcomed.

**Dr. Philip Ferguson:** I want to echo the feeling of collaboration. The biggest joy is working with others, especially the potential end users of this technology. Ultimately it is the empowerment that gets me and my research team excited.

**Final remarks by Brig Gen. Edward Vaughan:**

This is the 5<sup>th</sup> seminar in the Arctic Airpower Seminar series, now renamed as JABAS. During the 2<sup>nd</sup> seminar in Dec 2019, we met at Yellowknife to discuss energy and electric power production in the high north. There were political sensitivities that prevented us from publicizing the discussion at that time, but now we can re-energize those discussions via this new JABAS format. One comment on the “12 o’clock,” this is the high north, the due north approaches. We already have runways there, in Resolute Bay, Cambridge Bay, Alert, and other locations, so how do we find synergies with other stakeholders to mutually advance all causes? I appreciated the comments about rescue and disaster relief, “coopetition” with other world militaries, linking with climate change science, working with Indigenous communities. We need to listen as much as we talk. We might find working toward goals together means that all of us are better off.