Addressing Gaps and Barriers in International Arctic Science Research: Workshop Report

The organizers of the 3rd Arctic Science Ministerial (ASM3) are prioritizing the development of specific action items as a result of this 3rd Ministerial meeting in order to advance international scientific collaboration. In an effort to develop recommended actions that people perceive as useful next steps, a survey was sent to participating countries, Indigenous Peoples and organizations. The survey asked respondents to identify the opportunities, barriers, and gaps to increased international Arctic research.

Building on the ASM3 participant survey, a special online workshop on the gaps and barriers in international Arctic research was held in November 2020. The webinar opened with a summary of the feedback received from the survey. This summary was followed by a panel of speakers who presented recent synthesis reports on research gaps and lessons-learned from projects that have navigated many international barriers. After the panel, workshop participants broke out into sessions addressing a) data and infrastructure, b) education and capacity building, c) sustained observations, d) societally relevant research and e) visas, permits, and other bureaucratic hurdles. The aim of these breakout sessions was to develop and prioritize actions needed to more effectively address challenges and barriers to international Arctic research efforts. In keeping with the open and inclusive framework of the ASM3, a survey was put out asking for additional input in case people were not able to participate in the online workshop or had points to share following the online event. The results from the online survey were combined into the workshop outcomes and are summarized in this report. The aim of this report is thus to serve as the basis for recommended actions to be discussed at ASM3.

Workshop Presentation Highlights

Hiroyuki Enomoto and Embla Eir Oddsdóttir, Co-Chairs of the ASM3 Science Advisory Committee presented a short update on the results from the survey sent to participating countries and organizations. The survey resulted in the compilation of a wide-ranging list of opportunities and resources for scientists to engage more internationally. These resources will be made publicly available online so that researchers and the wider public may benefit from them. As the survey responses were being analyzed, it became apparent that more input and discussion were needed, which is what lead to the development of this workshop. Capturing the main topics mentioned throughout the responses, the workshop's breakout sessions concentrated on five themes: Data Management and Research Infrastructure, Education and Capacity Building, Sustained Observations, Societally Relevant Research, and Visas, Permits and Bureaucratic Hurdles.

Following the introduction was a panel composed of speakers presenting recent reports on gaps and barriers or presenting lessons learned from large international research efforts. The panel was moderated by Renuka Badhe, Executive Secretary of the European Polar Board.

Next, Hiroyuki Enomoto, who serves on the IASC Executive Committee, presented a synopsis of the International Arctic Science Committee (IASC)'s State of Arctic Science Report 2020, which summarizes research conducted in the Arctic and identifies emerging issues and gaps. The following issues emerging Arctic research issues were underscored: (1) Coupled Arctic Systems, (2) Pollution: sources, sinks and societal impacts, (3) Observing, forecasting, prediction and predictability, and (4) Societally relevant Arctic research. As scientists are working to address these issues, they are encountering gaps, particularly in the spatial and temporal coverage of data or research and interdisciplinary data exchange. The results in this report stress the importance of international science cooperation, particularly in science planning, to overcoming obstacles.

Then, Elle Merete Omma, Head of EU Unit, Saami Council, shared perspectives that resulted in the development of the Saami Council Arctic Strategy and several points on how to foster co-production of knowledge. She stressed that the traditional way of life is changing rapidly for the Saami people - not just because of climate change but because of economic development as well. To adapt, there are questions that need answers, and these questions formed the basis of the Saami Arctic Strategy. Their strategy document can serve as a way for researchers to tailor their projects to what is needed by Arctic communities and help scientists prepare for discussions on designing research projects together. From their experience in Horizon 2020 projects, the Saami Council wrote an article, "Co-creating research projects and personal experiences from Saami Council and Arctic researchers", which points to the need for transparency and the need for time to listen to and respect one another. She pointed out that this is basic knowledge, but questioned why co-creation of research projects does not happen more often. Funding agencies can plan a critical role in increasing projects with the co-production of knowledge. This can be done by supporting and enabling collaborative research; acknowledging and understanding that it is more time consuming than a 'traditional' science project. Prioritizing collaboration in funding calls and make it key criteria for funded projects is required, as well as accepting that with co-created research projects, outputs may come in different forms than the traditional science journal articles.

In May of 2017, the Ministers of Foreign Affairs for each of the eight Arctic states (Canada, Kingdom of Denmark, Finland, Iceland, Norway, the Russian Federation, Sweden, USA) signed the "Agreement on Enhancing International Arctic Scientific Cooperation". The goal of the Agreement is to increase cooperation and access among the Arctic countries by providing better access to infrastructures, research areas, facilities and data. The overall prediction of the Agreement is that increased scientific cooperation in the Arctic will lead to greater development of scientific knowledge across the region.

Building on the 2017 *Science* publication about the "Arctic Science Agreement Propels Science Diplomacy," the University of the Arctic, in cooperation with IASC and International Arctic Social Sciences Association (IASSA), sent out a survey in the spring of 2019 that focused on understanding bottlenecks and positive practices in scientific cooperation and access across the Arctic in order to gauge whether the Arctic Council's Arctic Scientific Cooperation Agreement (ASCA) will indeed help to increase scientific cooperation. Lars Kullerud, President of the University of the Arctic, briefly presented the main results of this survey in a report entitled, "UArctic Report on Scientific Cooperation within the Arctic: Understanding the Bottlenecks in Cross-Border Research". The report concluded that so far, most people have had good experiences with international collaboration. Those who encounter problems are most often those who actually do not have a proper partner in the country where they want to travel. If researchers had an established partnership with somebody in the region, who knows the area or is familiar with the kind of data with which they want to work, and/or who had established working with Indigenous Peoples, then they normally have very few problems. Going forward, the decrease in bureaucratic hurdles is imperative for increasing cross-border research in the Arctic. This survey showed that

existing partnerships and cooperation among the nations and research groups is needed for successful cross-border scientific cooperation. Some hurdles do exist, but the only way to remove those hurdles is to make sure that the content of the ASCA is known and that its recommendations are followed to avoid problems and resolve them when they arise.

Lars Kullerud commented that in theory the ASCA is a fantastic tool because it shows that the states around the Arctic do agree that science and knowledge are essential for the future of Arctic operations. It is a weakness, however, is that non-Arctic states are not part of it. Another weakness is that while Indigenous Peoples were involved in its negotiation, the ASCA may not have turned out to their satisfaction.

Anja Sommerfeld, project manager for the Multidisciplinary drifting Observatory for the Study of Arctic Climate (MOSAiC) Expedition followed with experiences from the largest-ever active Arctic research expedition, which aimed to investigate the region's climate system and substantially improve the weather forecasting and climate prediction models. The research vessel, *Polarstern*, was frozen into the central Arctic Ocean and drifted with the movement of the sea-ice over the polar cap towards the Atlantic Ocean between September 2019 and October 2020. Involved were seven ice breakers and research vessels, with 250 scientists onboard. Over the 13 years of planning, the MOSAiC expedition involved more than 80 institutes from 20 nations.

The main lesson learned during the planning phase and expedition itself is that one single nation or institute would not have been able to implement MOSAiC. While the initial idea for the expedition originated from a single institute, Alfred-Wegener-Institute for Polar and Marine Research (AWI), which advanced its initiation and implementation to provide a research platform, MOSAiC could only be carried out thanks to a massive number of international partners covering different aspects of the expedition, from the science to logistics and finances. A very important step during the planning phase was to involve IASC from an early stage, as they helped advertise and promote MOSAiC, its goals and its tasks, which helped draw other international institutes to join the expedition. Endorsements from science agencies and funding agencies was also important. In coordinating the activities, it was important to have one German scientist and one international researcher leading each scientific aspect of the expedition. In addition, to have an open data policy and an open data handling strategy proved key, as the expedition leaders wanted to ensure that all data was located on one platform and would be easily accessible and freely available.

MOSAiC offers proof that collaboration between different international research groups and scientific disciplines is possible and fruitful. MOSAiC is also an excellent example of the benefits of international logistical and financial cooperation, especially with regard to the sharing of infrastructure and joint funding. Collaboration with Russia was also noted as crucial for successful Arctic research. Ultimately, perhaps the clearest evidence of the promise of strong and intentional international collaboration is that MOSAiC continued despite the COVID-19 pandemic, while all other expeditions had to be cancelled.

Next, Terry Callaghan, Founder and Science Coordinator of INTERACT (International Network for Terrestrial Research and Monitoring in the Arctic), followed with an introduction to the INTERACT program and what it can offer the Arctic science community. He noted that there has been a generational shift in the program's leadership and that Margareta Johansson from Lund University is now the overall coordinator. Unlike many polar research programs which grow out of research institutes, INTERACT started as a completely bottom-up brainchild of nine research station managers in 2000 who felt fairly isolated. These managers shared common interests and encountered similar problems in running research stations, including questions of how to invite international guests and how to make fieldwork more feasible, successful, and safer. With an initial grant, they began to do collaborate more together. Soon, other stations joined – even without funding, in the early stages – because

they found realized working together was so important that funding became a secondary issue. Eventually, with grants from the EU, INTERACT has been able to offer over 1000 scientists the ability to collaborate across international borders find and gain new perspectives. Gradually, research stations in Canada, Alaska and Russia joined. Station managers have worked together to break down barriers such as obtaining permits, invitations to host scientists, and other bureaucratic hurdles. Together, the now 88 researcher stations that are part of INTERACT host approximately 5000 scientists every year. INTERACT's collaborative efforts have resulted in many important publications that can help scientists develop international collaborations and overcome some of the barriers to cross-border work.

Breakout Session Reports

Data Management and Research Infrastructure

For many years, a vision for a shared, publicly accessible system of Arctic observations and data has been discussed. Recently, the Arctic and Polar data communities have come together to better understand the Arctic data system, requirements, and possible ways forward. This has been achieved through a number of activities including the Polar Data Forum series, various EU-PolarNet efforts, the Arctic Observing Summit, the Arctic Data Committee, the emerging SAON ROADS (Roadmap for Arctic Observing and Data Systems) process and other initiatives. The following subsections summarize the key priorities that breakout session participants identified:

Important points raised during the discussion:

- Consider a variety of different data-related initiatives and actions ranging from small scope and short time frame to very large scope, long-term, international initiatives. The latter is particularly relevant with respect to the ASM process.
- Continue to work to ensure that the community is aware of existing resources such as data centers, working groups, conferences, training material etc. This includes informing research community members of where and how data should be submitted for long-term curation. Other resources such as inventories and databases documenting Arctic observing activities and making data more discoverable are also important (e.g. Arctic Observing Viewer).
- Wide-scale open data sharing is not yet fully part of international Arctic research culture. Often, it is only done within large projects and/or where funders require sharing. Data may still be seen as proprietary rather than a common good.
- Researchers can be motivated to share by using and promoting data attribution and citation as part of research practice. For example, submission to data journals and making these submissions part of researchers' publication records.
- Government and funding policies are critically important. Linking data submission and management to required project deliverables in some countries has succeeded in increasing sound data management.
- Making data findable, accessible, interoperable, and reusable (FAIR) is important and has multiple levels. FAIR acts as an important mnemonic and high-level vision, but also has very specific technical requirements that can be challenging to achieve. Adequate supporting resources are required.
- Protocols relating to ethical and appropriate use and sharing of Indigenous Knowledge are important. For example, the CARE Principles (Collective Benefit, Authority to Control, Responsibility, and Ethics) and other national or regional protocols such as the National Inuit Strategy on Research (NISR, Canada).

- A fundamental problem is that we often do not have Indigenous People(s) or their representative organizations at the table. We need to make progress in this regard.
- People are central to all of this work, so building better connections is important. Wherever possible, engage with and enhance existing activities rather than create new initiatives. Participate in processes such as SAON ROADS, Arctic Data Committee, ARICE, INTERACT, FARO and others to maximize the effectiveness of coordination. Connect initiatives by creating new "interfaces" rather than trying to create one large, central coordinating body. This aligns with the distributed database approach adopted by the information and communications technology community.

Suggested actions

- Work in partnership with Indigenous Peoples and their representative organizations to develop necessary policy and funding frameworks to ensure that Indigenous Knowledge and observations of the Arctic are an integral part of the broader Arctic data ecosystem.
- Increase the level of resources available to enhance FAIR data culture, practices and implementation. Start with the most achievable aspects (FA) while working towards full implementation.
- Value and provide added resources to support data community building, expanding education and training, coordination and engagement. This includes promoting the creation of interfaces between existing, effective, well connected initiatives to accelerate progress.
- Facilitate culture change from proprietary data model to data as a common good. This can best be done through enhancing outreach, changing funding policy, and rewarding data publication.

Education and Capacity Building

Education and capacity building are critical to building a sustainable Arctic, developing the workforce to address research needs, and creating global awareness of the global impact of changes happening in the Arctic. Education is a broad term that encompasses formal (i.e. curricula taught in schools and universities, including teacher training) and informal education (i.e. in museums, science centers, community settings, homes and increasingly in virtual learning environments). Capacity building is equally broad, spanning a range of issues from workforce development to the development of community resources. Given these broad topics and the short time for discussion, this breakout session focused mainly on discussing actions needed to support networks of educators and efforts connecting research to Arctic education, which in turn builds capacity.

Important points from the discussion:

- Foster more intra-Arctic exchange programs through University of the Arctic
- Create programs that provide financial assistance/travel support for people from Indigenous communities to attend and present at Arctic conferences (especially in Russia)
- Create programs that provide Arctic field research opportunities for teachers and students, and for local youth and students to participate in such research projects
- Enhance the sustainability of the organization Polar Educators International (PEI) to support local/national/international efforts to inspire the next generation to be knowledgeable about the Arctic
- Build national and local educator networks within Arctic countries that link to PEI, the international network of polar educators.

- Establish programs involving cooperation between researchers, Indigenous communities, and polar educators to create learning opportunities and knowledge exchange between the Arctic and non-Arctic communities
- Provide support for revising the IPY Polar Resource Book (Polar Science and
- Global Change: An International Resource for Polar Education and Outreach) including its Arctic sections and activities.
- Lack of broadband internet is a barrier
- There is a much bigger desire for exchanges between Arctic and non-Arctic than is currently funded. The needs of people in both places are different and should be considered for exchanges to be valuable for both groups
- A question was raised on what the relationship is between the Arctic Science Ministerial process and the Arctic Council's Science Agreement. At present the two are separate processes but it could be useful to analyze the relationships and synergies as well as formal connections between these two efforts.

Suggested actions

- Fund a secretariat to build capacity for PEI's work, especially by helping create a broader framework for polar educators that is inclusive of all types of education
- Fund the revision of the IPY Polar Resource Book (Polar Science and
- Global Change: An International Resource for Polar Education and Outreach) to continue the legacy of IPY
- Focus on teacher and researcher education and re-training in engagement with Arctic research and science communication
- Provide mobility for cultural exchanges both between Arctic regions and between Arctic and non-Arctic regions, travel scholarships, and allow for more flexibility for exchanges (especially short-term ones, which often are not eligible for funding, and those that don't match exactly to academic terms given the need for Arctic peoples to often be out on the land)
- Value educators and embed them in Arctic science from the beginning stages of planning research projects 'upstreaming' engagement with research. Relatedly, when scheduling meetings, consider the time carefully (educators often are not available during the day due to teaching schedules)
- Fund educators' expertise in co-developing resources with researchers, including those related to local and Indigenous cultures
- Fund infrastructure that directly supports access to education and science communication, such as high-speed broadband
- Include educators in conversations with each other and research organization efforts like the ASM3 webinar series
- Emphasize the process of research rather than solely disseminating the product
- Provide funding for translation for both resources and meetings, especially for Indigenous languages, to expand the reach of research and education efforts
- Build larger capacity by including Science Ministerial decision-makers in the Arctic education and outreach process
- Research and map educators/students/decision-makers to explore different perspectives rather than the historical process of "education from on high" which is not always based on the needs of the learner

Sustained Observations

Sustained observations are necessary to track, understand and predict the rapid changes occurring in the Arctic. These observations include ground-based observations set up and/or

conducted by researchers, Indigenous Peoples, government agencies, and citizens as well as air and space-based observations. The Sustained Arctic Observing System (SAON) has been in development for many years and continues to be the main vehicle through which international sustained observation coordination is discussed. As SAON, however, has not been sufficiently-supported, resources are urgently needed to take it from concept to operational. In addition to SAON, other observation programs and activities are contributing to our knowledge of the Arctic and should develop more collaboration. It is also imperative to ethically engage with Indigenous Peoples, as their knowledge of the Arctic is vast and critical to understanding the region in its entirety. Efforts to co-design research and co-produce knowledge with Indigenous Peoples are needed. This breakout session discussed a number of important needs and actions that need to be taken to move forward on the international need for sustained Arctic observations and the sharing of observational data.

Important points from the discussion:

- Embrace the “local turn” in Arctic observations by deeper consideration of local and indigenous knowledge
- Understand how to combine the different approaches of local and indigenous knowledge and academic research
- Create a mechanism to better link existing national observing systems and programs
- Define the role autonomous observing systems should have
- Task and resource SAON to implement its Roadmap for Arctic Observing and Data Systems (ROADS) to enable a framework for long-term support for existing observations, such as linking into national observation programs. This could be done by joining research-operational proposals, and by maximizing the use of existing observing platforms before establishing new ones
- Establish policy frameworks that commit to ensuring the long-term sustainability and viability of observing programs
- Define and measure “sustained”
- Pursue consistency, standardization and community best practices – e.g. “Develop, disseminate, use” - to ensure representation, quality and quantification of observations, together enabling the integration of multiple data sources;
- Define requirements/user-driven needs and pursue multi-purpose observations (in other words, one platform could have multiple uses)
- An extremely large percentage of observations are funded via time-limited research funds. Only a limited number of these observing programs have open and free data exchange or the resources to implement data sharing. There are also technological gaps including data communication problems. Clear guidelines for observation (resolution in time and space, quality, timeliness) are needed to truly close these gaps.

Suggested actions:

- Tackle a major challenge: match national interests with the international vision regarding observations and make national funding more effective by including international collaboration.
- Funding approaches to seeking/securing funding in an effective way - essential
- The game-changer would be to develop a means of setting pan-Arctic priorities for proposed and existing observation activities/projects as a framework for engagement and funding.
- SAON should be properly resources to lead/foster the mapping/integration of national and international initiatives, to align goals/funding with a pan-Arctic reach
- ASM and the Arctic Council should pursue a top-down political commitment to international Arctic research that complements and supports SAON’s -bottom-up

approach. Funding agencies may select initiatives from the priority list aligned with their interests.
- SAON may include a framework for funding projects led for by indigenous knowledge holders with the aim to frame their own questions and the use of the knowledge acquired.
- Enable the collection and use of Indigenous knowledge as a knowledge system in its own right; currently, Indigenous knowledge tends to be collected and applied within Western-based social science systems.
- Link sustainable observations to their operational uses, which return as value-added knowledge and services to Arctic communities; operational use of data from observations increases the likelihood of sustainability.
- Observations made as part of science projects should be included in long-term monitoring. It may help to ensure/fund observations for long term monitoring, which would require a mechanism or roadmap laying out how observing research campaigns can contribute to and/or evolve into long-term observations;
- Simplify frameworks for engagement and use existing mechanisms for new initiatives, as much as possible.
- Since observations are the conduit to producing data needed to understand systems, and the path from observations to data archives needs to be better structured.
- Stable funding for SAON is necessary, but more clarification regarding what a well-funded SAON would look like and would accomplish is key.
- Ensure sufficient resources to establish a SAON governance structure that can coordinate:
    - Mapping user requirements for products and services and translate these into requirements for observations (resolution in time/ space, quality, timeliness)
    - Design a pan-Arctic observation system
    - Connect national commitments to implement parts of the system (pooling resources to get the full system) in a manner that avoids duplicating work
    - Ensure that data are exchanged according to the FAIR principle

Societally Relevant Research

In order to advance societal relevance, we first need to understand what this means. The meanings of relevance would vary depending on scale (cross-Arctic (climate prediction), countries, local communities) and regional/local contexts. Consequently, such relevance can only be established via a meaningful process of community engagement that involves diverse stake-, rights- and knowledge holders early in the process of designing research. Identifying what we don't know collectively is of key importance to any work with communities and societal actors. In order to co-design research and co-produce results that will have relevance, this engagement must be meaningful and equitable in respect to all knowledge systems. Identifying knowledge gaps in a co-productive manner, however, consumes time and resources and thus often creates a barrier for both communities and scientists. To address this fundamental problem, we need to Institutionalize funding, engagement and connectivity within the work of both science agencies and academia and allocate funding and resources to communities to map out knowledge gaps and participate in research. This process could be facilitated by the continuous development of ethical guidelines and processes locally, nationally and internationally. Societal relevance could be further advanced by building community to community relationships across the Arctic to share information on existing challenges, knowledge, experience and co-production practices.

Important points from the discussion:

- Create more avenues for local communities to comment on proposed research, especially when it involves fieldwork
- Consider requirements and mechanisms of funding to support local or indigenous community research and/or participation.
- Fostering knowledge sharing and co-production internationally
- Actively promote and encourage diversity in research topics and teams.
- Actively channel more research funding into interdisciplinary (ex. social science / social science; social science / natural science; social science / engineering) research and projects.
- Seek to build funding bridges between North America: Europe/Nordics: Russia.
- Actively engage with stakeholders, such as the private sector.

Suggested actions

- Attain equal and equitable engagement of Indigenous knowledge holders and local communities in research
- Work with communities from the beginning (to define defining research questions and priorities) and focus on identifying community knowledge gaps
- Institutionalize community funding, engagement and connectivity within science agency's work
- allocate funding and resources directly to Indigenous communities to map out knowledge gaps
- Continue developing ethical guidelines, and possible developed shared guidelines for research in Arctic communities
- Facilitate community to community relationships (to increase societal relevance and support shared solutions
- Develop efficient search and rescue and pollution remediation preparedness.

Visas, Permits, and Other Bureaucratic Hurdles

The attendees discussed the role of the Arctic Council's Arctic Scientific Cooperation Agreement (ASCA) in overcoming some of the challenges mentioned in the title of the breakout session. Fran Ulmer reported on the current progress of the implementation of the ASCA, indicating that 1. The ASCA was based on the experience and advice from the research community and to be effective, the national contact points to the ASCA need to be informed by the community about any issues related to the scope of the ASCA, 2. The ACA planned to meet in 2020 to adopt terms of reference and discuss implementation procedures, but COVID made that unrealistic. Similarly, field research that had been planned and funded has been delayed due to COVID, so the usual issues with cross border research as well as ASCA implementation are all delayed. 3. The ASCA process should be evaluated in 3 to 4 years, after more experience and examples can be reviewed and potential modifications can be considered.

Several participants mentioned that researchers new to Arctic research who need to go abroad to do research were confronted with important challenges in terms of visas, licensing and permitting. The main challenge was the dissemination of information and the lack of a one-stop-shop to host all the information for the entire Arctic. Several participants mentioned available products that did this well, even if still to a limited extent. Polar Knowledge Canada, for instance, offers a webpage listing all licensing requirements as well as recommendations for northerner engagement. FARO expressed its willingness to help and several participants mentioned the INTERACT Practical Field Guide as a good model for such a handbook.

The remaining discussion focused on the necessity to push for international funding schemes, indicating that such funding could help to overcome many of these issues. The participants also discussed briefly the use of Memoranda of Understanding, as they can be a useful tool to overcome these issues. The last point of discussion focused on visas, building on an action point already submitted in the online document. Here, participants underscored the need to explore existing schemes (mostly bilateral agreements) facilitating visa delivery as a model for a potential ASM3 action.

Suggested actions

- Stimulate the implementation of the ASCA by encouraging the community to report issues, challenges and solutions to the national contact points to the ASCA.
- Foster the creation of a handbook on licensing and permitting in the Arctic

Relevant Materials

- IASC 2020 State of Science Arctic Science Report
- Sámi Arctic Strategy 2019: Annex: Building Knowledge in Sápmi, A List of Knowledge Gaps and Research Needs
- UArctic Report on Scientific Cooperation within the Arctic: Understanding Bottlenecks in Cross-Border Research
- MOSAiC Expedition
- INTERACT Publications
- ASM2 Statement
- Ongoing Polar to Global Workshop
- EU-PolarNet White Papers (5)
- 2020 Arctic Observing Summit Statement (see Section 4)
- Polar Data Forum and related workshops and publications (see "General Background" heading)
- FAIR Principles
- CARE Principles

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Appendix 1
Survey sent to ASM3 Participants

International Collaboration and Cooperation Survey

As one goal of the ASM3 is to increase opportunities for cooperation, coordination, and collaboration in international Arctic research, we ask for information that can assist researchers from other countries, international organizations, Indigenous Peoples and community members in getting involved with your projects. The information collected will inform the Joint Statement signed by Ministers and be made available to the international research community through the ASM3 final report. **As we seek key points from these questions, short answers and bullet points are encouraged.**

1. Does your country/organization provide specific opportunities for international collaborators to participate in activities? If so, briefly describe how (1500-character limit).
   E.g.: Does your country/organization provide international fellowships? Are there berths on research ships for international participants? Does your country/organization have joint funding/exchange programs with various countries/organizations? Are there specific links or resources for international participants to learn more about opportunities within your country/organization?

2. Does your country/organization provide specific opportunities or support for Indigenous Peoples and/or community involvement in Arctic research activities? If so, briefly describe how (1500-character limit).

3. In what area(s) of research would your country/organization like to see greater international collaboration occurring (1500-character limit)?

4. What does your country/organization think are the barriers to international collaboration? Do you have any suggestions on how those barriers could be lowered or removed (3000-character limit)?

5. The ASM2 Joint Statement also encouraged the involvement and participation in several international efforts dealing with Arctic science. Does your country/organization contribute to any of the following initiatives? *(Choose all that apply)*

   - ☐ Agreement on Enhancing International Arctic Scientific Cooperation by the Arctic States (Arctic Council)
   - ☐ Joint Program of Scientific Research and Monitoring of the Central Arctic Ocean (Agreement to Prevent Unregulated High Seas Fisheries in the Arctic Ocean)
   - ☐ 2030 Agenda for Sustainable Development
   - ☐ The Paris Agreement
   - ☐ Other: _____

6. A goal of ASM3 is to develop concrete actions from our discussions. To facilitate this process, please indicate what the most important outcomes your country/organization would like to result from each of the ASM3 Themes[1] (300-character limit per theme):

   - ❄ Theme 1: Observe
     Observing networks, Data sharing – towards implementation

[1] Draft themes as of 10 April. The specific wording of subtitles may change but the overall concepts of Observe, Understand, Respond and Strengthen will remain.

E.g. With the help of the Arctic Funders Forum, develop a mechanism to co-mingle funds internationally in support of coordinated observing

- Theme 2: Understand
  Enhance understanding and prediction capability on Arctic environmental and social systems and its global impact.

- Theme 3: Respond
  Sustainable development, Evaluation of vulnerability and resiliency, Application of knowledge

- Theme 4: Strengthen
  Capacity building, Education, Networking, Resilience – prepare future generations

7. Does your country/organization participate in ongoing international projects/activities such as Sustaining Arctic Observing Networks (SAON), Multidisciplinary drifting Observatory for the Study of Arctic Climate (MOSAiC), Svalbard Integrated Arctic Earth Observing System (SIOS), Pacific Action Group (PAG), Distributed Biological Observatory (DBO), etc.? If so, please list which ones and a short description on your involvement in each (less than 20 words each)
   E.g. The SAON Secretariat is financially supported by Norway through a grant from the Ministry of Climate and Environment.

8. Would your country/organization be interested in supporting the coordination/administration of international Arctic research and education efforts such as SAON, Polar Educators International, APECS, IASC, an ASM Secretariat, Arctic Funders Forum, IASSA, UArctic, etc.[2]? If so, who(m) would be the contact agency and/or person?

9. Does your country/organization have formally established Arctic science or research priorities? Arctic science or research strategy documents? Guidelines, diversity requirements, principles or codes of conduct for researchers? If so, please provide the references and links to the documents.

10. The Forum of Arctic Science Funders is a multi-lateral discussion platform to initiate new and enhanced collaborative scientific activities in the Arctic. This Forum is a direct result of the Arctic Science Ministerial. Does your country/organization participate in the Forum of Arctic Science Funders? If so, please describe what you see is the utility of the Funders Forum to the Arctic Science Ministerial going forward.

11. Please list any additional resources/links providing an overview of Arctic research/education in your country/organization.

[2] Sustaining Arctic Observing Networks (SAON): https://www.arcticobserving.org
Polar Educators International (PEI): https://polareducator.org
Association of Polar Early Career Scientists (APECS): https://www.apecs.is
International Arctic Science Committee (IASC): https://iasc.info
Arctic Science Ministerial (ASM) Secretariat: http://asm3.org
Arctic Funders Forum
International Arctic Social Sciences Association (IASSA): https://iassa.org
University of the Arctic (UArctic): https://www.uarctic.org

Appendix 2
Online Survey and responses

Community Input Survey on
Gaps and Barriers in International Arctic Research

To gather more community input for the 3rd Arctic Science Ministerial (ASM3), the organizers have put together a short survey asking for suggestions for policy-level actions to address research gaps and barriers to increased international collaboration. This survey is a companion to the 2nd ASM3 webinar on Gaps and Barriers.

As part of the ASM3 process, we will be hosting a special webinar on the gaps and barriers in international Arctic research. The webinar will be opened by with a summary of the feedback received from ASM3 participating countries and organizations to a series of questions about international research gaps, opportunities and challenges. Next on the agenda will be a panel of speakers presenting recent synthesis reports on research gaps and lessons-learned from projects that have navigated many international barriers with a short Q&A following. After the panel, participants will have the opportunity to participate in breakout sessions addressing a) data and infrastructure, b) education and capacity building, c) sustained observations, d) societally relevant research and e) visas, permits, and other bureaucratic hurdles. The breakout sessions aim to develop and prioritize actions needed to more effectively address challenges and barriers to international Arctic research efforts. The resulting prioritized actions will form the basis of recommendations published in the ASM3 report.

Input received before 9 November will be included in the breakout session discussions on prioritized actions. Input received after this date but before closing on the 20th, will be synthesized and incorporated into the results from the webinar as much as possible.

Actions based on overarching barriers

The webinar breakout sessions are attempting to gather information on overarching barriers to international collaboration.

Please describe the gap/barrier and be as specific as possible on policy-level actions that can/should be taken to address those.

Data Management and Research Infrastructure

- There is no centralized open access data base collecting all time-series applicable to Arctic research.
- There is an increasingly urgent need for research icebreakers capable to operate in the central Arctic Ocean, also in winter. Access to such facilities is for some research activities the only way to work, and we are seeing now how country after country invest in cheaper and smaller resources that are not really capable to handle the thicker ice in the central basin or in winter. At the same time those countries that has such capacity are not investing in the future and soon also the existing heavy research icebreaker will be to old top effectively and economically be used. Data management will sort itself out the same time as funding agencies provide the means for scientists to pen up and manage their data well. The current lack of management is entirely due to the fact that this has become yet another task for the scientists but with no support to get the job done.
- No agreed international data format makes it near impossible to carry out pan-Arctic environmental research.
- Greenland is still an unsecure third country without suitable level of data protection. Action could be ensuring that Greenland fulfills requirements.

- promote data sharing among scientists, and multidisciplinary approach to the study of issue gaps, international exchange between scientific people interested to access to local research infrastructures
- Differing open science data policies across nations
- National Arctic research infrastructures may not always be used at their full capacity, while we all know that their cost is important. INTERACT is a great example to improve this. However, in order to go around the normal tendency to make national assets available in priority to scientists from the same nation, a barter system between nations, similar to the one developed in the context of the Antarctic peninsula, could ease the exchange of services, providing easy access to scientists from other countries. Raw principle: once the yearly selection of national projects has ended, the operator evaluates the remaining access slots to a given facility that could be put on an "open Arctic market". Applications are received from scientists of other nations. A selection process leads to access to some applicants, corresponding to a token. National tokens valid through a multi-year balance allow then scientists from the first nation to get access to other national assets through the same mechanism.
- Relevant Funding is needed

Education and Capacity Building

- In marine sciences in Iceland to date there has been limited research effort on targeted Arctic research.
- Online tools are inadequate for "ocean literacy", students should have access to all observations for free.
- Would be positive in terms of understanding Arctic changes that Arctic external scientists learn from indigenous/traditional knowledge. So, education programs could include local Arctic people as lecturers.
- Gradually increasing of educational efforts are supporting general capacity building in Greenland
- improve the access to webinars, data sharing, social and communication free access to videos and other materials used as education resources (publications, reports)
- Redundancy across nations exposing additional gaps
- Relevant Funding is needed
- As a participant who is attending for the first time, it was good to hear the general briefing about each organization before splitting up into the break-out rooms. Therefore, it would also be nice to start the session with an introductory presentation as 5 min on what ASM3 aims from the allies to contribute with. Because as far as I noticed there were couple of people only talking about the sort of educational/capacity building, but unfortunately the rest of the group was in silence which is not productive atmosphere to me at all. To take also their attentions, I believe quick info given will help them to imagine or focus themselves on a certain idea. Regarding the Education and Capacity Building, we are currently working on a project which increases citizen science through learning kits in the schools. With the 16-week of learning package, we aim to reach out students, pupils, as well as teachers, via not only traditional setting lecture, but also experiencing other applications such as museum visits, basic lab measurements, creating a sketch on climatic change and so forth. What really motivates me is collaborating with other partners to come together with a decreasing our carbon/water footprint idea as the output of this effort. To sum up, if we can also replicate idea such like that, we will both have a common data pool among the organizations as well as the projects they use to awareness raising which will bring huge impact to create new capacity on the educational way on the aim.

Sustained Observations

- Atmospheric observing over the Arctic Ocean is close to non-existing. There are only a few short-lived buoys on the surface and essentially nothing that observes the vertical structure of the atmosphere; temperatures & humidity, winds and clouds. There is plenty of satellite observations, but their lack of precision is not outweighed by the large amounts. Therefore, there is an urgent need for a new paradigm. In this new paradigm, the reference-level of traceable data rests on icebreaker expeditions that need to be frequently reoccurring. These

are the only platforms that can house the logistics necessary. The baseline network of observations has to rest on satellites while the comprehensive level is reanalysis. For this to work, substantial investments have to be made on infrastructure but also on model and data assimilation development as well as on new observation techniques.
- A multidisciplinary cabled infrastructure would allow real-time data flow across the Arctic.
- Place traditional/indigenous knowledge-based observations at the same level of consideration than technological observations. Satellites and images can reach macro scales while indigenous observations provide information at smaller scales. Both kinds of information are essentially different, they can work in parallel, not integrating them. It is not a matter of "integration" but of complementarity. Uncertainty can be reduced by gathering different types of information and knowledge.
- Greenlandic Institution especially ASIAQ possess long term climate data, sharing data in collaboration with Greenland Ecosystem Monitoring (GEM) and INTERACT
- increase the amount of funds to support monitoring cruises at international level on identified emerging research objectives i.e. environmental status, trends, main threats like pollution
- Infrastructure or remote monitoring limitations
- Relevant Funding is needed
- An extremely large percentage of observations are funded via time limited research funds. Far from all have an open and free data exchange or the resources to implement data sharing There are technological gaps incl. data communication problems There need to be established clear requirements for observation (resolution in time and space, quality, timeliness) to really access the gaps

Societally Relevant Research

- Weather predictions across the scales from days to months as well as climate projection knows no boundaries; they are global problems. What is relevant to the indigenous people of the north is in this respect relevant to the global population especially in the northern mid-latitudes. The lack of observations hurts the former a few days earlier; that's all. So, we either solve this problem YOPP-style or - not at all.
- Environment observations from the offshore industry are inaccessible, even though they have more value for research than for the industry itself.
- Health, Social Research, sustained climate observations, living resources are current focus areas in Greenland Research
- AOS2020’s theme, Observing for Action, attempted to include the citizen observer as a player at the table for International Arctic research. As a member of WG2, for Adaptation and Mitigation, being included was the first step. However, there is more to be desired in the realm of adaptation and mitigation. Taking the citizen’s observations and then linking action that is timely and recognizable will be key in keeping the citizen observer at the table.
- To reply to societal needs linking research to practical applications. i.e. monitoring of environmental status and apply measures to preserve it, favor knowledge dissemination
- Language barriers
- Relevant Funding is needed

Visas, Permits and Other Bureaucratic Hurdles

- No opinion.
- Entering Greenland goes through Danish Immigration Service, which complicates the Process.
- To make easier the release of permits to access to Arctic research stations
- Timelines and approvals required prior to obtaining documentation
- The relevant procedure is needed to facilitate the overcoming of bureaucratic barriers

Actions needed to address gaps and barriers based on ASM3 Themes

Please describe the gap/barrier and be as specific as possible on policy-level actions that can/should be taken to address those.

Theme 1: Observe
Observing networks; Data sharing – towards implementation

The desired action for this step is to provide support for the implementation of an observation and data sharing system, and to develop collaboration between scientists and Arctic communities. Information on the status of ongoing changes in the Arctic is still limited. There are vast data gaps, especially with long-term data which has largely been observed only since the satellite era. There is also room for improvement with data sharing. As observations in the Arctic require considerable human resources and costs due to its remote and harsh environment, it is difficult for a single country alone to build and maintain a long-term observation system. It is, therefore, necessary to collaborate on a system of systems with an international platform to promote cooperation for observing and data sharing. It was noted in ASM1 and ASM2 that the Sustaining Arctic Observation Network (SAON) initiative can play a key role in resolving these issues. Following the recommendations in the previous meetings, ASM3 will seek an organizational mechanism to provide support to SAON and other necessary actions. Empowering national focal points and offices in each country as well as focusing on recommendations from international assemblies would be the first step.

- Implement open access of scientific data paid for by Icelandic tax payers and make this data accessible to SAON and other data sharing platforms.
- The gap is that what is not observed cannot be organized. The atmosphere over central Arctic Ocean is essentially unobserved except by satellite and the quality of this is insufficient. So, management and organization are fine, but in this case, it does not help
- Please do not overlook the part that volunteers, citizen scientist & students, pre-college & NGOs are eager to help, freeing researcher's & "gradual students" to concentrate on higher level (spatial & statistical analysis). Leaving them more time to succumb to peer group pressure to publish "public relations journal articles appreciated & understood (hopefully-ideally) only among publishing Scientists".
- Support initiatives for ocean smart cables and satellite communication that allow better communication to and from Arctic communities. Unifying international data standards for sharing research observations and support international data standards for new observations.
- The barrier here is a matter of mindset. So, a mindset shift is necessary from scientists and policy makers. Understand and acknowledge that science is not the only means to gather knowledge and information. For instance, the following sentence describes this issue: "there are vast data gaps, especially with long-term data which has largely been observed only since the satellite era". Traditional knowledge is based on greatly long-term observations and can provide -if it is adequately understood- information about Arctic context from the past (much before that the satellite era). The mindset shift entails that traditional knowledge is not integrated/included into scientific assessments, they are different knowledge systems and should be approached in parallel.
- acquisition of in situ data on the terrestrial and aquatic (marine, freshwater) domains, through planned surveys on holistic vision; attention must be paid to data interpretation and knowledge sharing, creation of databases accessible to scientists and also to local stakeholders
- Ensure enough resources to establish a governance structure that can coordinate - Map user requirements for products and services and translate these into requirements for observations (resolution in time and space, quality, timeliness - design observation system - ensure national commitments to implement parts of the system (pooling resources to get the full system) - avoiding duplication of work - ensure that data are exchanged according to the FAIR principle

Theme 2: Understand

Enhance understanding and prediction capability on Arctic environmental and social systems and its global impact

The desired action for this step is to recognize the complexity of the system connecting all environmental and socio-economic components, and to encourage further interdisciplinary research. The interconnected effects of both globalization and global climate change are impacting Arctic communities and the environment. It is increasingly understood that the Arctic environment is not only a very complex system on its own, but it is connected to the global weather and climate system as well as the global socio-economic system. The people who call the Arctic home also depend inextricably on the Arctic environment and its living and non-living resources. The changes in the natural environment in the Arctic will have cascading impacts on the social environment, affecting the rest of the world as well. We must understand the structure and dynamics of this complex system.

Reliable predictions are essential for developing effective planning for mitigation and adaptation measures and processes. To enable informative predictions, our understanding of Arctic change needs to improve significantly. ASM3 will strengthen international collaboration for comprehensive and holistic Arctic science to improve the assessment of ongoing change and prediction for future change.

- Targeted research funding, within the Rannis framework, for interdisciplinary Arctic research would facilitate the desired collaboration across science disciplines to create the knowledge needed for sustainable management of the Arctic environment.
- Understanding unavoidably relies on observations. No observations, no understanding. Or worse, maybe misunderstanding.
- Speaking from the perspective of a longtime proponent of interdisciplinary studies and comparing three different models as a graduate student with degrees both in biology and earth sciences, modeling has great potential for solving these kinds of grand challenges or on the dark side “my model is better than yours or conclusively proves climate change has not it’s the . . . -abuse.” Ensemble modeling is Trendy Currently for Predicting Global Change and extremes. Model calibration & verification is easier said than done. QC & QA of both inputs & outputs are tedious & time-consuming but often overlooked, and so on ...
- Improve data sharing culture and multi-disciplinary data portals.
- It has been stated in Theme 2 that reliable predictions will be “essential for developing effective planning for mitigation and adaptation measures and processes.” The language is commendable in that it embraces Anticipatory and Adaptive governance approaches, this is progressive thinking, as it addresses the need for a more timely response to the various rapid fire domino effects being observed in the Arctic environments. As all climate change effects are transboundary in nature, the greatest barrier to timely responses will be the inability for exchange across lines. Whether it is the exchange between a national border and what is needed within a larger ecosystem or the expert research community and the citizen observer; it will be crucial to speed not only the exchange of data and observations but will also be imperative that collaboration is met with action that reflects success for all parties involved. Sluggish anticipation and lack of inclusivity are the gaps herein Theme 2.
- data interpretation and simulation of future scenarios

Theme 3: Respond

Sustainable development; Evaluation of vulnerability and resilience; Application of knowledge

The desired action for this step is to recognize the necessity of knowledge-based decision-making, and to establish a framework for taking effective measures.

Warming at twice the speed of the global average, the Arctic is experiencing drastic changes in both the physical and ecological environment. The changes are visible in many natural phenomena, and their impacts to culture and society are also becoming clearer. It should be noted, as reported in the IPCC Special Report on the impacts of global warming of 1.5ºC, that further warming will continue at

least until mid-century, and will likely occur regardless of any prompt action taken to reduce carbon emissions.

It is, therefore, a matter of urgency to consider and implement adaptation and mitigation measures for the sustainable future of the Arctic including taking global action to slow down climate change, seeking compromise between development and protection in the Arctic, and supporting adaptation and mitigation strategies for Arctic residents. This approach requires making full use of the Arctic Knowledge system. ASM3 will emphasize the necessity of active response based on the best available knowledge and evidence, which we obtain through observation and understanding.

- Political will and governmental financial support is vital for responses. Any form of public awareness would help beginning mitigation measures asap.
- Implementing anything be it academic, private industry, or government run or sponsored, is best based experience instead of class-work according to John Dewey's book, whom I agree with based on over 30 years of field work.
- Arctic communities have adapted to extreme changes along the history, without the intervention of science. Perhaps scientific data/evidence -per se- are not the only answer. So, work on the development of a real knowledge-based framework, not including traditional knowledge outputs into a scientific frame. Develop a framework based on the complexity that implies to have different knowledge systems. To this, more workshops, more collaboration, more respect to residents.
- Pay attention to the results of observational studies (data on effects of climate changes or human impacts on Arctic regions) to decide for actions to be taken to mitigate alterations

Theme 4: Strengthen
Capacity building; Education; Networking; Resilience – prepare the next generation

The desired action for this step is to recognize the urgent need and identify gaps in capacity building, education and networking, both in Arctic and global communities, and provide pathways of support.

The problems triggered by warming in the Arctic are long-lasting and will impact culture and society for generations. It is the responsibility of the current generation to pass on the knowledge needed to meet the challenges of the changing Arctic and to establish the network and infrastructure required for supporting the work of future generations. ASM3 will encourage and strengthen these efforts in capacity building, education, and networking with participating countries in order to build resilience.

It is necessary to encourage and support young scientists and knowledge holders who will become the next generation of leaders. It is critical that people around the globe see the Arctic as linked to their lives and not as a distant and irrelevant place. It is also crucial to build capacity in education for Arctic residents, including Indigenous communities, acknowledging the importance of practicing their knowledge within their education system. Adapting education systems to include traditional and local knowledge is essential for Arctic residents in building resilience within their changing environment. Empowering citizens is also important for fostering a stable observation system that includes community- driven observation.

- Educate the children and they will change the world as they grow up. Make use of modern multimedia to make engaging educational material for children, teenagers, and young adults. No not make them afraid of the changes, empower them and make them feel like they have the power to reverse the negative change for the better.
- "Yea verily"- to quote dearly, departed, dad PhD in word-smithing & Ten-year
- Develop efficient search and rescue and pollution remediation preparedness.
- Increase the involvement of research Institutes dealing with research in Arctic regions at international level, built research networks as wide as possible (at European level)
- The Arctic environment has a great response to abrupt changes on both global climate and weather. In order to better understand the complexity of the system, the course of actions has to be implemented via supporting citizen science, hence the learning/engaging tools within the educators and the partner organizations which work on environment and sustainability in one page. Hereby, the working packages to be prepared will help shape the project timeline

throughout the year. The packages in detail can be as specific as itself, however, one of the working packages should have definitely focused on the learning kit and actualization program for not only students and their teachers, but also a wider network, including companies to switch systems toward eco-friendly solutions at the end of the day. Focusing the learning kit, the preparation for the lectures can be focused as 2 hours of lecture per week in terms of having the optimum efficiency from the student. While one week of the lecture were giving place on theoretical knowledge, the following week will be focusing on previous topic-based activities such as Arctic sea ice melting as the topic to provide didactic information with very basic knowledge referring to science, the following week, which will be the hand-made learning, will make the experiment of Albedo effect in the basic school conditions. In this way, students and teachers can experience the case and the study at the same time in one package. I would happy to work and provide more on the teaching-learning package in order to reach out more students/teachers/householders and thus more communities to raise awareness on future polar researches and its relation with climatic changes.

Comments/suggestions

If you have any additional comments or suggestions for the ASM3 organizers, please share them below.

- I have already submitted input but would like the option to comment on Gaps and Barriers Webinar report.
- The time for action is now!
- Thanks!
- The four themes are being discussed at the Ministry

Appendix 3
Workshop Program

Third Arctic Science Ministerial Webinar Series

Addressing Gaps and Barriers in International Arctic Science Research Workshop

As part of the 3rd Arctic Science Ministerial (ASM3) process, we will be hosting a special workshop on the gaps and barriers in international Arctic research. The workshop will be opened with a summary of the feedback received from ASM3 participating countries and organizations covering international research gaps, opportunities and challenges as part of the ASM3 Science Process. Next on the agenda will be a panel of speakers presenting recent synthesis reports on research gaps and lessons-learned from projects that have navigated many international barriers. After the panel, participants will have the opportunity to participate in breakout sessions addressing a) data management and research infrastructure, b) education and capacity building, c) sustained observations, d) societally relevant research and e) visas, permits and bureaucratic hurdles. The breakout sessions aim to develop and prioritize actions needed to more effectively address challenges and barriers to international Arctic research efforts. The resulting prioritized actions will form the basis for recommendations in the final ASM3 Report.

Relevant Materials

- IASC 2020 State of Science Arctic Science Report
- Sámi Arctic Strategy 2019: Annex: Building Knowledge in Sápmi, A List of Knowledge Gaps and Research Needs
- UArctic Report on Scientific Cooperation within the Arctic: Understanding Bottlenecks in Cross-Border Research
- MOSAiC Expedition
- INTERACT Publications

Workshop Program
11 November 2020
Start Time: 13:00 UTC

Housekeeping remarks

Review of the Program
Lindsay Arthur, Icelandic Ministry of Education, Science and Culture

Opening Remarks
ASM3 Science Advisory Board members Embla Eir Oddsdóttir and Hiroyuki ENOMOTO

Panel on research gaps and lessons-learned from projects that have navigated many international barriers.
Moderator: Renuka Badhe, Executive Secretary of the European Polar Board

1. IASC State of the Arctic Science Report 2020
   Panelist: Hiroyuki ENOMOTO, IASC Executive Committee

2. Saami Council Arctic Strategy: Building Knowledge in Sápmi, A List of Knowledge Gaps and Research Needs
   Panelist: Elle Merete Omma, Head of EU Unit, Saami Council

3. UArctic Report on Scientific Cooperation within the Arctic: Understanding the Bottlenecks in Cross-Border Research.
   Panelist: Lars Kullerud, President of UArctic

4. Lessons Learned from the MOSAiC Expedition
   Panelist: Anja Sommerfeld, Project Manager MOSAiC, AWI

5. Methods Used by INTERACT to Overcome International Barriers
   Panelist: Terry Callaghan, Founder and Science Coordinator of INTERACT

(Short Question and Answer Session with Panelists)

(10 mins) Health Break

(30 mins) **Breakout sessions**

1. Data Management and Research Infrastructure
2. Education and Capacity Building
3. Sustained Observations
4. Societally Relevant Research
5. Visas, Permits and Bureaucratic Hurdles

(25 mins) Report back

Wrap-up and explanation for where results will be published

End: ~15:00 UTC – 15:15 UTC

Page Break

Details on Breakout Sessions

The goal of the breakout sessions is to develop a list of specific actions that would help to reduce gaps and barriers. Each breakout group will have a moderator and a reporter. The reporter will share the list of actions in the report back after the breakout groups. Potential actions need to be added to suggested discussion topics.

Data Management and Research Infrastructure *Moderator: Henry Burgess* / *Reporter: Peter Pulsifer*
Suggested discussion topics*:*

- We have been discussing the issue of data sharing for a long time – the interest from most scientists is there, why isn't it happening? In detail, what is needed to make data sharing easier?
- What steps can be taken to implement ethical data sharing, especially with Indigenous Peoples?
- Programs like INTERACT are doing a great job of helping to increase access to field stations. ARICE is helping to coordinate research opportunities on ships. What lessons can we learn from the obstacles they have overcome? Are there still barriers that these programs have not been able to tackle that the ASM3 process could help with?

Education and Capacity Building *Moderator: Mia Bennett / Reporter: Louise T. Huffman*
Suggested discussion topics:

- UArctic and APECS are important mechanisms to help build research capacity and training opportunities. Are there more these groups could do to reach out to non-Arctic countries?
- Besides higher education, are there other training opportunities that could be created to help build capacity in the Arctic?
- Polar Educators International is working to try to connect educators around the world to inspire the next generation to be Arctic knowledgeable. What can be done to help this organization grow? Are there lessons from EDU-Arctic that can be learned*?*

Sustained Observations *Moderator: Karin Lochte / Reporter: Rodica Nitu*
Suggested discussion topics:

- SAON has been around for a while and is often looked to as the 'solution' for long-term sustained observations, yet we still don't seem to be making fast enough progress in this area. SIOS is one of the more productive observation systems. What does SIOS have that SAON needs to be successful? What specific actions are needed?
- On an international level, what steps can be taken to build capacity for equitable engagement of Indigenous Peoples in Arctic observing activities?
- Besides the major observing systems, how can individual science projects contribute to long-term observations? Is there a mechanism to submit datasets somewhere?

Societally Relevant Research *Moderator: Embla Eir Oddsdóttir / Reporter: Andrey Petrov*
Suggested discussion topics:

- Are current research foci addressing the needs of society? Are there areas where more knowledge would help with adaptation strategies? What would be needed to get that research done in an expedited manor?
- How can co-design of research be improved? Are there mechanisms that exist that can serve as a model for how co-design can and should be done? If not, what would such a mechanism look like and would it vary by country? Geographic location? Science topic?
- Often societally relevant research needs collaboration between natural and social sciences. How can these relationships be created and nurtured?

Visas, Permits and Bureaucratic Hurdles *Moderator: Fran Ulmer / Reporter: Hugues Lantuit*
Suggested discussion topics:

- Securing visas and exporting samples are a major hurdle in international science collaborations. Are there examples of how this has been expedited? Do bi-lateral or other multi-level MOUs help? Are there other things that could be done as an international community to help reduce these barriers?
- For a scientist not involved in large international projects, figuring out how to navigate the practicalities of creating an international partnership can be a hindrance. Are there resources to help? If not, what would such a resource look like?
- What steps can the ASM participants take to support the need for Indigenous Peoples to move across the national borders of their homelands in order to meet and collaborate freely?