The Arctic Practices System - Use and Benefits of Arctic Practices in Observing, Data Management and Applications

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Abstract

Progress is needed on bridging world views, concepts and practices represented in monitoring and information systems. Documented practices improve knowledge sharing across the Arctic. As Arctic observing grows, Arctic practices support scaling of observing systems and consistency in quality of data. Arctic practices also support the definition and collection of Shared Arctic Variables envisioned under SAON's Roadmap for Arctic Observations and Data Systems (ROADS). Ultimately, knowing the methods used for monitoring and data offers transparency and furthers trust.

Access to Arctic practices is currently fragmented and limited, since these practices are held on diverse platforms across disciplines and cultures. An Arctic Practices System (APS) can give more uniform discovery and access to standards and practices (following the FAIR and CARE principles) and sustainably maintain documents for long-term access. The initial step for an APS is to gather requirements from potential users, including a broad range of stakeholders and rights holders. Certain high-level characteristics, described in this paper, are anticipated including wide breadth of engagement, clearly defining benefits, needs for community services, intellectual property rights and support of capacity development. Results of a preliminary requirements survey are summarized in this paper. However, APS characteristics and performance cannot be defined by a small group of experts, but must evolve from the needs of the full spectrum of Arctic stakeholders and Indigenous Knowledge holders through a co-design process. Currently funded work under the CAPARDUS project with Indigenous Peoples has been delayed by COVID restrictions. For a systematic path forward, it is recommended that an Arctic Practices System be identified as a component of the Arctic observing system by Sustaining Arctic Observing Networks. The APS should be developed in conjunction with the ROADS process and the process of defining SAVs. It is recommended that this be a topic considered during AOS 2022.

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1. Introduction

Understanding the dynamics of the Arctic environment, and the impacts that climate change is having on things such as hazards and food security, is essential from a global perspective, but particularly important for local and regional populations. AOS 2020[1] focused on the need for funding, observing and other resources and the need to bring together communication of all stakeholders and Indigenous Knowledge holders to build on a foundation of shared and understood methods. To further such communication, and to provide an underpinning for scaling of Artic observations and knowledge, a collection of commonly accepted practices (methods and standards) would make a significant contribution. This paper describes how documented "Arctic practices" (methods, standards, etc.) could be made more widely available through development of an Arctic Practices System. When considering widely available Arctic practices, it is important to keep in mind that one practice does not fit all situations, so we are not discussing the adoption of a specific practice across a spectrum of observers, but the transparency in understanding the methods used. This builds a necessary trust in the data and greater willingness to link data effectively.

Transparency and trust is particularly important when the data comes from many different locations and is aimed at supporting a diversity of stakeholder and rights holder communities and objectives. The need for best practices in the Arctic has been a topic of discussion for many years. It was recognized by data experts as they prepared for the International Polar Year (2007-2009). Working in an international collaborative environment presents many data management challenges, including "identification or creation of appropriate archives, maintenance of data integrity throughout the data lifecycle, use of appropriate content and interoperability standards, *dissemination and use of best practices*, reconciling different data sharing and disciplinary traditions, appropriate funding mechanisms, and many more." (Parsons et al 2006)

For Arctic practices, considerations of co-design and broad stakeholder and rights holder participation increases the value that Arctic practices can have in creating and maintaining Arctic observing systems (Eicken, et al 2011, Eicken, et al 2016, Christoffersen et al 2019). The documentation of Arctic practices was identified in the Ocean Decade Arctic Plan where, "relating to risks and disasters, translating scattered knowledge, providing supporting tools and *documenting best practices* therefore constitute a dedicated challenge in need of several specific lines of actions." (Ocean Decade Arctic Plan 2021) Thus, there is increasing recognition that access to and understanding of best practices for the Arctic is emerging as a priority.

Many historical and contemporary documents, including those mentioned above, use the term "best practice". From an individual or community viewpoint, the term "best" is ambiguous. Many individuals are hesitant to describe their methods because they do not know if they are "best". Others recognize that "best" is context dependent. In this paper, we use the term "Arctic practices", while recognizing the legacy and general use of the term "best practices."

[1] https://arcticobservingsummit.org/summits/aos-2020/

This paper examines concepts for an Arctic Practices System (APS) for use throughout the Arctic science and observing communities as a resource for sharing and learning about practices. As values vary across the Arctic, we do not *a priori* make the assumption that a single system can meet the needs of all potential users. However, the capabilities of such a system must provide value to all potential users. We are at the very early stage of community engagement for APS requirements collection. COVID has been a barrier for traditional in-person outreach and engagement. Thus, we have developed tools and approaches to gathering initial input from a range of potential users and have begun to test these tools. Moving forward, we hope to engage as many potential users of an Arctic Practices System as possible, including a broad range of stakeholders and rights holders. We do reflect that a companion effort, the Ocean Best Practices System (OBPS), is operational and has found strong support across the ocean research and observation efforts (Pearlman, et al 2019) and see the Appendix for an OBPS summary description). The OBPS currently serves as a testbed for APS concepts.

What are the impacts of Arctic practices? Documented practices improve knowledge sharing across the Arctic. As Arctic observing grows, Arctic practices support scaling of observing systems and consistency in quality of data. Arctic practices support the definition and collection of Shared Arctic Variables (SAVs) envisioned under SAON's Roadmap for Arctic Observations and Data Systems (ROADS) [Starkweather, et al 2020], with the recognition that societal impact metrics should be an inclusive process for all stakeholders (see AOS 2020 Summary[2]). The approach to essential variables was started more than two decades ago, first with climate variables (Bojinski, et al 2014, SBSTA 2007), and then with ocean variables (Lindstrom, et al 2012) and biological variables (Muller-Karger, et al 2018). Documented practices form a broad foundation for interoperability and consistency in monitoring essential variables. Simply said, they are believed by many to be necessary. Following a similar process, Arctic practices can support the creation and evolution of SAVs.

2. What are Standards and Practices?

There is a range of practices and standards to consider when looking to support the information needs across the Arctic. Table 1 presents a spectrum that moves through informal methods at the top to legally enforceable documents at the bottom. The most appropriate type varies depending on users' needs and objectives. No single instantiation fits all cases.

In the most general sense, a standard is something established by custom, general consent or authority as a model to be compared against, a rule for measuring the quantity, weight, extent, value or quality of something. When we speak of technical standards, we are speaking of published documents that establish specifications and procedures designed to maximize the reliability, interconnectivity, interoperability, and performance of materials, products, methods or services. There are different forms of standards.

[2] https://arcticobservingsummit.org/summits/aos-2020/

Table 1 Types of formal and informal standards and practices

Type	Origin	Process	Authorship	What is the form?	How is conformance determined, enforced?	Who is affected?	What is the impact on those affected?
Norm/ethic/tradition	need for functional society	informal	members of a society	interpretation	parental, societal pressure	members of a society	Allows for cohesion and interpretation
Practice	practical experience	informal	practitioners	practice	voluntary	self-selected	Provides norms for processes; encourages interoperability and allows for fluid evolution
De Facto Specification	need for compatibility	formal, informal	practitioners	as built	non-binding	practitioners	Widely adopted process, may be a best practice
Standard Profile/Extension	need for more specificity	formal, informal	standards adopters	Software	conformance clauses	specific community	Consistency of implementation, easier to assess conformance
De jure standard	compatibility, interoperability, reliability,	managed development	affected stakeholders	Device, procedure	conformance clauses	narrow/broad stakeholder community	Provides formalized, stable process descriptions for production and interfaces
Code	need for safety, reliability	deliberations	responsible officials	practice	law enforcement	local jurisdiction	Defines requirements for process implementation for safety and conformity
Policy/Law	public interest	lawmaking	lawmakers	practice	law enforcement	jurisdiction	Legal requirements for societal safety and economic growth
Treaty	international relations	negotiations	government officials	practice	economic, military	nations	Establishes relations between different governing bodies for security and commerce.

Table 1 shows *practices* in the context of other types of standards. *De jure* standards, for example, are distinguished mainly by the fact that they were created under processes managed by a standards development organization. The benefit of working under a Standards Development Organization (SDO), such as ISO or IEEE, is that it provides the rules and governance for standards creation that are needed to ensure fairness and transparency, as well as the mechanisms to assist in the distribution and maintenance of the standard. A community can modify a de jure standard to suit its particular interests by creating extensions, where new elements are added, or profiles which define specific ways certain elements of a base standard must be used.

There are also *de facto* standards, which can be just as rigorous as *de jure* standards, and have influence by virtue of their widespread adoption. An example of evolution from de facto to de jure status is the Portable Document Format (PDF). Created by Adobe in 1993, it became a widely-used de facto standard and in 2005 it became a de jure standard as ISO 19005-1:2005.

Methodologies, standard operating procedures, handbooks or traditional community practices are different forms of Arctic practices. While there is flexibility, there is also a need to identify the most appropriate type for a given need or application.. There is also a question of to what extent the future Arctic Practices System should include all these types of practices and standards.

3. Considerations for an Arctic Practices System Design

To design an Arctic Practices System, a series of underlying principles should be considered. Some of these are listed below. With the ones listed and others that emerge, further debate is encouraged so the principles gain a community-wide consensus.

3.1 Stakeholder and Rights Holder Engagement

Broad stakeholders and rights holders (including academic researchers, industry, Indigenous organizations or knowledge holders and others) should be engaged throughout the creation and evolution of APS and Arctic practices from initial concepts to implementation and use. Co-design is often mentioned in engagement approaches. There are many perspectives on co-design/co-production, but an underlying requirement is that all participants are operating on an equal basis throughout the cycle. Participants offering their perspectives and representatives of their communities should be equitably compensated. It is important to recognize that true co-production, under the current grant-driven funding system, is challenging.

3.2 Stakeholder and Rights Holder benefits

There needs to be a clear rationale for how each of the Stakeholder and Indigenous Knowledge Holder/rights holder communities' benefit from an Arctic Practices System and how it can support their needs and goals. There has been some work within the Community Based Monitoring actions to document good practices (Johnson, et al 2016; Danielsen, et al 2021]); these efforts have mostly been led by academic researchers.

3.3 Community Services

While it is not clear if Arctic communities and organizations would care strongly about building an Arctic Practices System in the abstract, the system could be framed more concretely and narrowly with practices relevant to a particular theme, need or interest. For cross-disciplinary interests, a single access point to all the disciplinary repositories is required.

3.4 Retaining context

Western sciences and knowledge systems assume that knowledge can be dissociated from context and shared abstractly and impersonally. Practices that exist as "know how" or as knowledge transmitted orally across generations are sometimes recorded, written down, etc. but usually for a specific purpose or use. A practices system should be able to retain the context of the practices to understand if a practice is appropriate for another specific purpose.

3.5 Open Access and Intellectual Property Rights

Documenting and sharing practices to inform a very broad audience may not be something that Indigenous communities feel comfortable with. Industry has the same concerns from a competition perspective. Academic researchers may wish to limit access to information until their objectives have been met. On the other hand, governments and funding agencies are moving toward open access for research and information. The open access policy must be balanced against community rights for information control. When considering Intellectual Property Rights, data rights and sovereignty, it is important to implement standards designed to offer protection of sensitive data and uphold Indigenous data sovereignty as reflected in the CARE principles ([Carroll, et al 2020). Similarly, establishing acceptable practices for attribution of contributions in the knowledge cycle is important. Failure to do so risks the 'theft' of intellectual property from participants who are not well-versed in seeking authorship credit.[3] These issues are being addressed for data and should also be addressed for intellectual rights connected with practices.

3.6 Sharing Know-how

To achieve geographic and culturally attuned coverage, practices should be accessible in different languages, modalities (e.g., documents or videos or audio recordings) and sourced from all regions where Indigenous Peoples and other stakeholders reside. Multilingual and trans-cultural interpretation (rather than simple translation) requires financial support that is currently not available.

3.7 Capacity building

To sustain use of APS and the practices it contains, it will be critical to engage early career researchers and new members of relevant stakeholder and Indigenous communities in becoming familiar with the system. Integrating educational tools into the design of the system will accelerate how new participants learn methods and practices.

3.8 Managing Development in a COVID Environment

All of the challenges above are impacted by limitations due to COVID-19. Restrictions that prohibit in-person meetings continue to hamper our ability to build a community around discussions of Arctic practices, and it tends to limit our engagement with those having limited internet bandwidth. This makes it difficult to demonstrate what an Arctic Practices System could look like and, more challenging, to obtain specific feedback on priorities for development.

Discussions around these points and others that will emerge from community discussions will guide the requirements, design and development of the Arctic Practices System.

[3]See AOS 2020 Indigenous Food Security Working Group synthesis: https://arcticobservingsummit.org/wp-content/uploads/2021/10/AOS2020_WG3_synthesis.pdf

4. The Arctic Practices System - Concept and requirements

Arctic monitoring engages diverse observers from different knowledge systems, countries, and communities with their own traditions and procedures. Building trust, transparency, understanding and consensus means bringing together the diverse actors in the Arctic and this requires time, resources, background knowledge, travel funds, meeting organization, etc. Efforts are being made in observing, data management and community-based monitoring. Generally, progress has been made through various working groups, committees, online hackathons etc. However, engagement is still limited. We need to recognize that not all actors have the knowledge, time, or funding to engage in practices activities (e.g.. de jure standards activities that can take long periods of time (sometimes years), travel etc.) .

Ensuring transparency and full access for the documents in the APS goes beyond simply creating an open, documented process. There is an increasingly large body of work in fields such as science and technology studies (STS), critical data studies, decolonial theory, and Indigenous data sovereignty that highlights the importance of understanding the context and process of developing and applying theory, methods, and standards (broadly defined). This body of work confirms the importance of using methods, standards and processes with dialogues that are equitable and inclusive, consider power imbalances, and are mindful of historical and current injustices and misuse of research, observations and data (Bowker & Star 2000, Lampland et al 2009, Kukutai & Taylor 2016, Inuit Tapiriit Kanatami 2018, Carroll 2020). Failure to recognize and engage in these dialogues will limit the ability to establish the full transparency and trust needed to effectively share observations and knowledge.

Requirements for the Arctic Practices System need to be developed by all Arctic stakeholders through a co-design process, as mentioned in the previous section. Co-design is short for collaborative-design. Collaboration is more than just tapping into the individual knowledge that internal and external stakeholders possess. It is about discovering collective perspectives on the systems.[4] There are many perspectives on co-design and it is not clear there is a single definition widely accepted across cultures. For the purposes of this paper, co-design is the act of creating with all stakeholders and knowledge holders, specifically within the requirements and design development process, to ensure that usable results will meet everyone's needs. While conceptually powerful, the practical implementation of co-design is not clear to many stakeholders.

For the APS, the plan was to collect and analyze requirements from "around the table" discussions, during workshops and through in-person meetings and interviews. Unfortunately, COVID-19 removed the option for in-person meetings. After waiting for almost two years, the current process was started in 2022 through virtual interactions, with the hope that in-person meetings would be permitted soon. In the interim, the requirements are being collected through interviews and surveys . A survey was initiated at the beginning of 2022 which asked respondents to identify key characteristics of the APS. There were forty responses, 75% from academics and

[4] https://medium.com/@thestratosgroup/co-design-a-powerful-force-for-creativity-and-collaboration-bed1e0f13d46

research facilities. The others came from government, NGOs and funded research projects. Initial results of the survey are provided here. *Greater participation from other types of organizations and communities is being solicited.*

From the survey, the highest priorities for APS requirements were ease of use, discovery of practices and access to practices as shown in Figure 1.

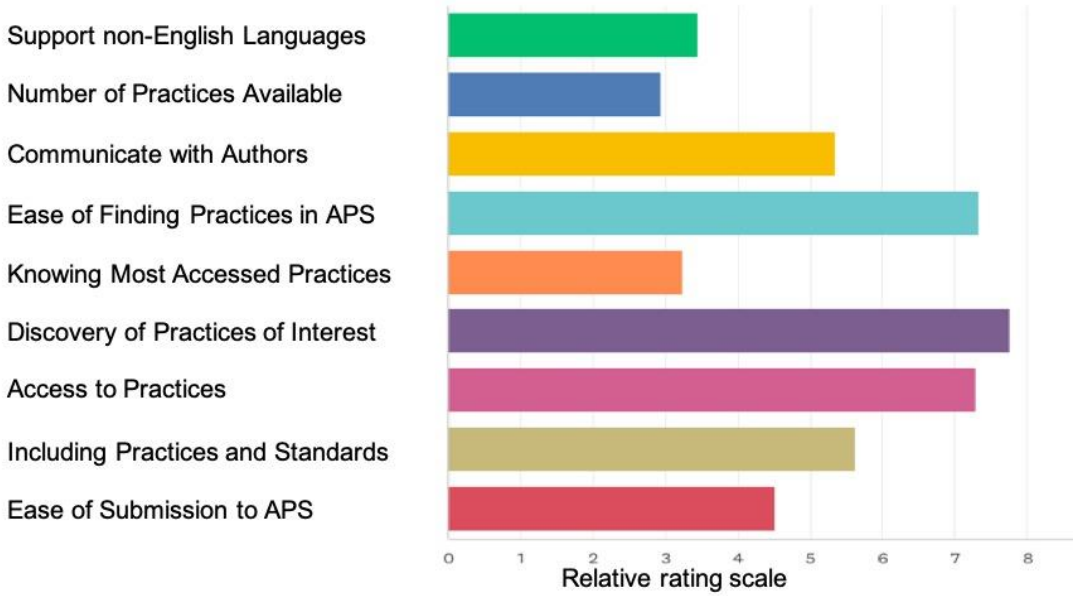

Figure 1: Responses for the question: What are your priorities for APS characteristics in descending order of importance?

An interesting priority is the desire to be able to communicate with the authors of practices. This is a reflection that Arctic stakeholders are a broad and diverse community that do not routinely interact. It was anticipated that the availability of non-English language documents would be a priority and, as a consequence, non-English documents were introduced into the APS test bed (OBPS). This was not indicated in the survey responses. We believe this is due to the fact that the survey respondents to date have been largely academics who use English as their international collaboration language.

In another question, the priority choice of user access methods was requested. 97% of the respondents selected a web browser. The dominant organizations of survey respondents were academic and research institutions that typically have good internet access. Because more than one option could be selected, one third also indicated that a mobile app should be considered. Experience in developing countries with limited communication infrastructure, indicates that the use of mobile phones for information retrieval is the dominant method, suggesting that alternative access approaches may be important in the Arctic.

Additionally, 80% of the respondents felt that supporting capacity development was extremely or very important. Finally, respondents were asked if they create practices in their work and 97% answered affirmatively. This suggests that there may be a body of practices that can be

recommended by the community and quickly brought into an APS. From this perspective, respondents were asked in what format do they record or maintain the knowledge of their practice(s). Examining the highest three priority selections from each respondent, 74 % indicated documents, 12 % indicated human experts and 6 % chose photos. It is interesting that videos were not selected by anyone as the highest priority. This may again reflect the background of the respondents. Finally, when asked how their community currently managed collections of practices, there was no consistent answer.

In summary, the survey indicated a strong interest in the creation of a sustainable repository that can support open discovery and access to Arctic practices. There is a backlog of practices that could be readily available to Arctic Stakeholders. When asked for a vision for three to five years, one respondent answered with a vision of: “just having access to practices used across the Arctic with understanding that they may need to be flexibly adjusted to meet specific needs.” Another respondent offered a vision of better documentation and democratization, adding the comment that “having expertise limited to a number of individuals and their research groups makes it hard for new perspectives to contribute to the research community.”

The requirements highlighted in the survey are technically feasible. For an effective design, cultural and capacity challenges may dominate the evolution of the APS. We recognize that this survey, which was started in 2022, is a first step of an approach for engagement of the broad range of stakeholders and knowledge holders who observe, operate in and/or live on Arctic lands.

5. Summary

The Arctic observing community is expanding its global capability for monitoring the Arctic, drawing on a wide range of resources from space systems to local community-based monitoring. Progress is needed on bridging world views, concepts and semantics represented in monitoring and] information systems (Pulsifer 2020). This requires collaboration across geographies, natural environments, cultures, stakeholder needs and policies. There are many challenges in doing this, some of which were discussed in the previous sections. Trust and mutually engaged collaboration are two key areas.

Access to Arctic practices is currently fragmented and limited, since these practices are held on diverse platforms across disciplines and cultures. An Arctic Practices System can give more uniform discovery and access, if it has widespread community buy-in and a critical mass of practices. It can link methods that may be related or interdependent. It can link people who create a practice with those who use them. Practices ranging from technical aspects of observations to policy should be considered. Supporting the ROADS process, working with research programs, and engaging with community-based monitoring practitioners and Indigenous Knowledge Holders are some of the areas that should be addressed in moving forward with an Arctic Practices System.

The form of the Arctic Practices System is not yet known; whether it is a single system or a system of discipline- or geographically-related systems? APS characteristics and performance cannot be defined by a small group of experts, but must evolve from the needs of the broad spectrum of Arctic stakeholders. This is not a one step process, but a systematic engagement with key communities. Communities should be approached through various means - surveys, panel discussions, interviews, community outreach efforts, preferably through in-person engagements. The process must be based on the concepts of respect, reciprocity, and responsibility. This includes appropriate engagement of Indigenous peoples, communities or organizations through the entire APS design cycle with informed consent and attribution of contributed knowledge. These principles need apply not only to the design, but also to the implementation and the life cycle of practices eventually contributed to the APS.

What work is funded and being done to develop an APS at this time in the CAPARDUS Project? The CAPARDUS project is examining multiple aspects of an APS concept. Working with Indigenous Peoples to understand their interests and the potential benefits that an APS could provide is planned, but was put on hold due to COVID. While on hold, CAPARDUS is starting to approach other Stakeholders in the academic research and policy sectors. Second, CAPARDUS is looking at the spectrum of standards and practices (Table 1 and other models) with an initial focus on how these apply to observational data. Third, a compendium of preliminary requirements will be collected and a conceptual APS design is part of the funded project. Resources for building an APS are not included in CAPARDUS. Relevant work, though not APS specific, is being done in projects such as the Arctic PASSION Project[5] and the RNA CoObs (Research Networking Activities for Sustained Coordinated Observations of Arctic Change (CoObs RNA)[6]. Cooperation between Global Initiatives such as the Ocean Decade Arctic Regional Organization and the Ocean Decade endorsed “OceanPractices” Programme (managed by the OBPS) will provide additional opportunities for dialogue and recommendations.

We anticipate that there will be needs to test ideas/requirements that are gathered to get feedback on their feasibility and extend the co-design through feature choices considered for the APS. The existing Arctic Community segment of the Ocean Best Practices System can continue to serve this function under the guidance of the ROADS process, the CAPADUS Project and the IOC OBPS.

6. Recommendations

6.1 SAON Engagement

To provide a systematic path forward, it is recommended that an Arctic Practices System be identified as a component of the Arctic observing system by Sustaining Arctic Observing Networks (SAON). The APS should be developed in conjunction with the ROADS process and the process of defining SAVs. It is recommended that this be a topic considered during AOS 2022.

[5] https://arcticpassion.eu

[6] https://sites.google.com/alaska.edu/rna-observations/

6.2 Process for APS Design

This paper recommends further engaging the SAON working groups, the Arctic Council and regional organizations such as the European Polar Board and the US Interagency Arctic Research Policy Committee in the requirements collection. Indigenous organizations and communities should be engaged as early as possible and throughout the design and development. The specific process for Indigenous engagement should be developed with input from Indigenous organizations.

7. Acknowledgement

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9. Appendix - Ocean Best Practices System

In the ocean domain, the Ocean Best Practices System (OBPS) (https://www.oceanbestpractices.org/) was created to serve the need for a collection of practices that was cross-discipline, end-to-end from observations to applications and sustained collections based on open (FAIR) principles (Wilkinson, M. et al 2016). OBPS has taken a co-design approach with ocean science, operations and applications, and there is interest in exploring the possibilities and need for an Indigenous co-designed practices system as we begin the journey to APS. Over the last five years, the OBPS collection has grown to more than 1500 practices covering all disciplines of ocean science, data management and applications. The repository's content is indexed by all the major search engines and harvested by such services as Google Scholar, Scopus, OpenAIRE, ASFA, etc. To support such indexing, the repository assigns Digital Object Identifiers (DOI) to submitted best practices or uses DOIs already assigned. Advanced natural language technology has been incorporated into the repository to improve coherent discovery of documents with diverse formats. Search and automated indexing capabilities are extended into the text within each document to tag words and phrases via text mining and natural language processing techniques (Buttigieg, et al 2019).

The OBPS has an Arctic Practices section which serves as a model for an independent Arctic Practices System (APS). This testbed supports the EC H2020 Project CAPARDUS.[7] The APS model has served to assess some of the APS capabilities desired to support the broad Arctic community. The challenges relating to the acceptance and use of ocean best practices for the Ocean Decade[8] were considered in a recent publication (Pearlman, et al, 2021). They are similar to those we expect for an APS. The challenges discussed are at a local, regional or even global level.

[7] https://capardus.nersc.no. CAPARDUS objectives are : (1) establish a comprehensive framework for development, understanding and implementation of Arctic standards related to climate, environment and sustainable development; (2) identify and document common practices as basis for development of standardization, building on the Ocean Best Practice System (www.oceanbestpractices.org); and (3) engage communities active in the Arctic including research and services, Indigenous and local communities, commercial operators and governance bodies in defining Arctic Practice System.

[8] www.oceandecade.org