

SEARCH Arctic Observing Assessment

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Contents

INTRODUCTION.....	2
KEY ORGANIZATIONS AND PROGRAMS.....	3
FUNDING AGENCIES	3
COMMITTEES	4
ORGANIZATIONS.....	6
GLOBAL OBSERVING SYSTEMS OR NETWORKS.....	8
SPECIFIC OR REGIONAL PROGRAMS AND PROJECTS	12
GOVERNMENT-SPONSORED GROUPS.....	16
DATA NETWORKS, MANAGEMENT SITES, PORTALS.....	17
SELECT PAST PROGRAMS AND PROJECTS.....	19
HISTORY OF ARCTIC SCIENCE OBSERVING IN THE U.S.	19

Introduction

This document was produced by the *Arctic Observing Working Group* within the NSF program [SEARCH](#), the Study of Environmental Arctic Change. The document is posted on the [SEARCH website](#), and is updated at least annually. Corrections or potential additions to this document be sent to the [SEARCH Project Office](#).

The initial challenge for researchers and stakeholders interested in programs designed for observing change in the Arctic is to identify the goals, activities, and plans of the many various national and international initiatives. Keeping track of these initiatives and their associated meetings and conferences is difficult even for groups like SEARCH, let alone for individual researchers and stakeholders. For example, there are two different entities with the acronym AOS, two with the acronym ADC, and two with very similar acronyms, IASC and ISAC. The International Arctic Science Committee maintains a list of [Polar Acronyms](#) for organizations, programs, networks, studies, and assessments. In addition, the Scott Polar Research Institute maintains a [directory](#) of polar [organizations](#), [museums](#), and [libraries](#). Finally, there are many scientific and research societies associated with the Arctic, e.g., the [International Arctic Social Sciences Association](#) (IASSA), and the [Society for the Study of Indigenous Languages of the Americas](#) (SSILA), which are not represented in this document.

The variety of entities involved in Arctic research and observing is vast. A general categorization of these entities includes:

- A. Funding agencies. These include NSF-AON or the European Commission, with funded projects but no systematic, coordinated network, and no comprehensive, integrated plans for Arctic observing. Some funding agencies (e.g., NASA, NOAA) have coherent within-agency plans but struggle to coordinate with other funding agencies with different missions.
- B. Committees with limited, multi-group governmental membership with recommendation and coordination responsibilities but no funding for projects (e.g., IARPC), to large NGO committees that can fund projects or workshops (e.g., IASC).
- C. Organizations, such as Arctic Council, SAON, or IASC. These may be governmental or NGOs, or a mix, and they tend to have designs and visions of broad international observing networks but few funded projects.
- D. Global observing systems or networks, typically large in scale. Examples include WCRP, CGOS, or GOOS, and most of these systems have an environment-specific purview and focus on only oceans, or permafrost, or glaciers, or climate, and with various funding levels.
- E. Specific projects. These can be local to circum-Arctic, and range from projects such as SEARCH—that are more organizational and research-support oriented—to projects such as ISAC or IPY that have broad goals similar to SAON and SEARCH but with limited funding, to more research-oriented projects such as MOSAIC (substantial funding but somewhat limited in scope), and INTAROS (good funding, limited duration, pan-Arctic in scope).
- F. Government-sponsored groups that write reports and recommend policies, such as PRB, USARC.
- G. Data networks, programs, or portals. These range from broad, well-funded networks (e.g., NSIDC or ADC), to broad information portals (e.g., Arctic Portal), to more dedicated data programs or repositories nested within large-scale organizations, programs, or individual projects (e.g., ADC, ABDS).

An annotated list of the main organizations, funding agencies, programs, and major meetings or summits that focus on or have important components related to scientific observations of change in the Arctic is included in the next section on Key Organizations and Programs.

Key Organizations and Programs

SEARCH. The [Study of Environmental Arctic Change](#). The SEARCH program is funded by the U.S. National Science Foundation (NSF), is assisted by ARCUS, the [Arctic Research Consortium of the United States](#), and functions to support the Arctic research enterprise for agencies, the international science community, and other stakeholders interested in the changing Arctic.

SEARCH is a U.S. program with a mission of *Advancing scientific understanding and collaboration to help society respond to a rapidly changing Arctic. Towards this mission, SEARCH:*

- *Generates and synthesizes research findings and promotes Arctic science and scientific discovery across disciplines and among agencies.*
- *Identifies emerging issues in Arctic environmental change.*
- *Provides scientific information to Arctic stakeholders, policy-makers, and the public to help them understand and respond to Arctic environmental change.*
- *Facilitates research activities across local-to-global scales, with an emphasis on addressing needs of decision-makers.*
- *Collaborates with national and international science programs integral to SEARCH goals.*

Observing Change Panel. In 2005, a SEARCH report from a large, NSF-sponsored science community meeting recommended three broad activities to examine Arctic change: Observing, Understanding, and Responding to change. Three “panels” were set up by SEARCH to help coordinate efforts on these three main activities, and based on that report NSF formed the Arctic Observing Network (AON) program with a call for proposals. The SEARCH Observing Change Panel (OCP) helped to coordinate the network from the perspective of the scientific community and NSF; the OCP operated until 2016.

Arctic Observing Working Group. In 2016, the new SEARCH program (with funding from NSF) chartered an Arctic Observing Working Group, which has the task of reviewing the current state of Arctic observing programs, and suggesting how SEARCH may best continue or modify the work of the OCP or help to coordinate observing programs for Arctic scientists and stakeholders (this report).

Funding Agencies

AON. The [Arctic Observing Network](#) is an NSF funding program initiated in 2006.

The goal of AON is to enhance the environmental observing infrastructure required for the scientific investigation of Arctic environmental system change and its global connections. AON encompasses physical, biological, social, cultural, and economic observations, including indigenous knowledge, of the land, ocean, atmosphere (troposphere and stratosphere) and social systems.

- The AON program at NSF is nested within the Geosciences Directorate, Office of Polar Programs (OPP). The Arctic Sciences Section in OPP includes programs in Arctic Natural

Sciences; Arctic Social Sciences; Arctic System Science; as well as the Arctic Observing Network. The 2016 announcement for Arctic sciences had an anticipated budget of \$40M/year for ~75 awards. Currently there are ~59 funded awards specifically in the AON program.

- Note that of the three broad activities initially recommended by SEARCH and the science community in 2005 (Observing, Understanding, and Responding to Arctic change), only the Observing component has had a specific call for funding and has been funded by a specific, dedicated program at NSF, the AON program.

EC. The [European Commission](#) is the executive of the European Union and funds research studies (€8.5B in 2017) on topics from jobs to energy to [climate action](#) and the [environment](#) (€400M in 2017). The [INTAROS](#) project is an example of an EC-funded Arctic observing initiative (see description of project in list below). Publications, data, and other research information can be accessed or tracked with the EU [Open Science Monitor](#) tool.

U.S. Government. Various U.S. agencies such as [NASA](#), [NOAA](#), [DOE](#), [ONR](#), DOI, and many others have specific, coherent research missions that are focused on Arctic environments or Arctic observing. In general, these “mission agencies” support large, targeted missions rather than the smaller, “individual-driven” science grants supported by NSF. The Interagency Arctic Research Policy Committee (IARPC, see below) works to coordinate the Arctic research and observing efforts of these agencies.

Similar governmental funding agencies operate in many countries with interests in the Arctic.

Committees

IARPC. The U.S. [Interagency Arctic Research Policy Committee](#) was established by the Arctic Research Policy Act (1984) and chartered by the White House in 2010 as a subcommittee under the [National Science and Technology Council](#) (NSTC). IARPC is not a funding agency but helps to coordinate Arctic research by 16 U.S. agencies and produces and implements five-year national plans for Arctic research.

IARPC, which consists of principals from 16 agencies, departments, and offices across the Federal government, is charged with enhancing both the scientific monitoring of, and research on, local, regional, and global environmental issues in the Arctic. In order to meet the Nation's economic, scientific, and environmental needs, IARPC envisions a prosperous, sustainable and healthy Arctic understood through research coordinated among Federal agencies and domestic and international collaborators. IARPC is chaired by the National Science Foundation, and cooperates with the State of Alaska, indigenous organizations, academic institutions, non-governmental organizations, the Arctic Council, and other international partners.

AOS (Arctic Observing Systems). IARPC’s 2017-2021 [Arctic Research Plan](#) established nine collaboration teams, including one on [Environmental Intelligence](#) that has a sub-team specifically for [Arctic Observing Systems](#).

U.S. AON (Arctic Observing Network). The U.S. AON committee was established as a result of the White House Ministerial Meeting in September 2016 (*see entry below under Government Sponsored Groups*). Initially, the committee was a response to the external review of SAON (Sustaining Arctic Observing Networks, *entry below*) suggesting that national committees of participating countries be formed. To allow for greater flexibility than might be afforded as a

particular national franchise committee under SAON, the committee name was changed to U.S. AON, and it currently exists as an integrating ‘layer’ considered to be the “observing part” of IARPC. It has an advisory board that is chaired by Sandy Starkweather (NOAA) and Will Ambrose (NSF).

Discussions of the U.S. AON Board and members of the IARPC AOS team are focusing at present on specific “tasks” (research, data, etc.) that should be defined and supported and how U.S. AON can function as an outlet for helping scientists and stakeholders contribute to these tasks. NOAA has expertise in setting up observational networks and initially will take the lead in the U.S. AON development.

IASC. The [International Arctic Science Committee](#).

IASC is a non-governmental, international scientific organization. The [Founding Articles](#) committed IASC to pursue a mission of encouraging and facilitating cooperation in all aspects of Arctic research, in all countries engaged in Arctic research and in all areas of the Arctic region. Overall, IASC promotes and supports leading-edge multi-disciplinary research in order to foster a greater scientific understanding of the Arctic region and its role in the Earth system. Representatives of national scientific organizations from all IASC member countries form the IASC Council, which is the policy and decision-making body for IASC that meets once a year during the Arctic Science Summit Week.

FARO. The Forum of Arctic Research Organizations.

FARO aims to facilitate and optimize logistics and operational support for scientific research in the Arctic. The forum encourages international collaboration for all those involved in Arctic research. It typically convenes at the Arctic Science Summit Week.

AOS. The [Arctic Observing Summit](#) meetings are developed and planned by ISAC (the [International Study of Arctic Change – not to be confused with IASC](#)), and they are outreach events of SAON within IASC.

AOS is an international, biennial forum of scientists, agencies, Indigenous Peoples’ organizations, Arctic community members and the private sector. Its purpose is to coordinate the design, development and implementation of a comprehensive and sustained pan-Arctic observing system at the international level. The International Study of Arctic Change (ISAC) leads the development and planning of the AOS in partnership with SAON and local organizers. SAON works to support and strengthen the development of multinational engagement for sustained and coordinated pan-Arctic observing and data sharing systems that serve societal needs, particularly related to environmental, social, economic and cultural issues. AOS 2016 is the third Summit, with previous events held in 2013 in Vancouver, Canada and 2014 in Helsinki, Finland. The fourth AOS is scheduled for 2018.

ADC. The [Arctic Data Committee](#) serves IASC and SAON to promote and facilitate international collaboration towards the goal of free, ethically open, sustained and timely access to Arctic data through useful, usable, and interoperable systems.

ADC does the following: (1) Advise IASC and SAON on matters related to data management and data sharing where data are defined in the IASC Statement of Principles and Practices for Arctic Data Management (April 16, 2013) (The Statement). (2) Contribute to the understanding of the nature and structure of the Arctic data system in the context of the global data system. (3) Promote and enable ethically open access to data, norms of fair attribution and use of data, and long term preservation of data. (4) Facilitate the adoption, implementation and development (where necessary) of standards that will enable free, open and timely access to data. (5) Facilitate interoperability of data and systems as needed to support the needs of researchers, Arctic residents, decision makers and others. (6) Establish expert groups to examine specific questions or coordinate the

implementation of data management and sharing solutions. Partnerships with existing or proposed initiatives driven by members of the Arctic science and data community and Northern communities will be encouraged. (7) Coordinate the review of data management plans submitted for consideration by IASC under the terms of The Statement.

NAG. The IASC [Network on Arctic Glaciology](#) is formed from the Working Group on Arctic Glaciology.

NAG aims to address rapid changes in Arctic ice masses by initiating scientific programs and facilitating international cooperation between glaciologists and climate modelers in order to develop the understanding of Arctic land ice and its role in global climatic and environmental change. The objective is to facilitate research on the dynamics and mass budget of Arctic glaciers to help assess the impact of climate change in the Arctic region and to stimulate collaboration between glaciologists and climate modelers. The focus is on the effect of glaciers on sea-level change and on the fresh water input into fjords and embayments.

ICARP. The [International Conference on Arctic Research Planning](#) is convened periodically by IASC and its partners to identify key scientific questions and issues pertaining to the Arctic.

ICARP I, held in Hanover NH 1995, reviewed the state of Arctic science and resulted in a series of IASC-supported research projects. ICARP II, held in Copenhagen 2005, developed twelve forward-looking science plans and resulted in several follow-up international projects and programs, mostly within the framework of the IPY 2007-2008. ICARP III was held in conjunction with the IASC 25th anniversary in 2015 and was specifically identified as a cooperative activity in the agreement between IASC and the International Arctic Social Science Association (IASSA) and University of the Arctic (UArctic).

Organizations

Arctic Council. The international [Arctic Council](#) was formed in 1996 by eight founding countries.

The Arctic Council is the leading intergovernmental forum promoting cooperation, coordination and interaction among the Arctic States, Arctic indigenous communities and other Arctic inhabitants on common Arctic issues, in particular on issues of sustainable development and environmental protection in the Arctic. Arctic Council assessments and recommendations are the result of analysis and efforts undertaken by the Working Groups, and decisions are taken by consensus among the eight Arctic Council States, with full consultation and involvement of the Permanent Participants. The eight Arctic States are Canada, the Kingdom of Denmark, Finland, Iceland, Norway, the Russian Federation, Sweden, and the United States. The six indigenous peoples' Permanent Participant organizations are the Aleut International Association, the Arctic Athabaskan Council, the Gwich'in Council International, the Inuit Circumpolar Council, the Saami Council, and the Russian Association of Indigenous People of the North.

AMAP. The [Arctic Monitoring and Assessment Programme](#) is one of the six Working Groups of the Arctic Council and focuses on providing information pertaining to monitoring and research.

AMAP is designed to deliver sound science-based information for use in policy- and decision-making in the circum-Arctic region. Its assessment activities are internationally coordinated, subject to rigorous peer-review and make use of the most up-to-date results from both monitoring and research. AMAP's work is conducted according to a mandate determined by the Arctic Council Ministers and Senior Arctic Officials, the AMAP Strategic Framework and the (bi-annually updated) AMAP Workplan.

CAFF. The [Conservation of Arctic Flora and Fauna](#) group is one of the six Working Groups of the Arctic Council and focuses on biodiversity of Arctic systems.

CAFF serves as a vehicle to cooperate on species and habitat management and utilization, to share information on management techniques and regulatory regimes, and to facilitate more knowledgeable decision-making. It

provides a mechanism to develop common responses on issues of importance for the Arctic ecosystem such as development and economic pressures, conservation opportunities and political commitments.

CBMP. The [Circumpolar Biodiversity Monitoring Program](#) is administered by CAFF.

CBMP is an international network of scientists, government agencies, Indigenous organizations and conservation groups working together to harmonize and integrate efforts to monitor the Arctic's living resources. The CBMP focuses its efforts on five key program areas: (1) [Data management](#) (the Arctic Biodiversity Data Service), (2) [Capacity building](#), (3) [Reporting](#), (4) [Coordination and integration of Arctic monitoring](#), and (5) [Communication, education and outreach](#).

ABDS. The [Arctic Biodiversity Data Service](#) portal is operated within CAFF.

Ministerial Meetings. *The Council holds [Senior Arctic Officials'](#) and [Ministerial Meetings](#) roughly every six months and two years, respectively. The most recent Ministerial meeting took place in Fairbanks, Alaska on 11 May 2017. At that meeting, the United States turned over the Chairmanship to Finland.*

SAON. The [Sustaining Arctic Observing Networks](#) is a process that is co-led by the Arctic Council through the Arctic Monitoring and Assessment Program (AMAP) and the International Arctic Science Committee (IASC). It was initiated by the Arctic Council in 2007 and formalized in 2012.

SAON's purpose is to support and strengthen the development of multinational engagement for sustained and coordinated pan-Arctic observing and data sharing systems that serve societal needs, particularly related to environmental, social, economic and cultural issues. SAON promotes the vision of well-defined observing networks that enable users to have access to free, open and high quality data that will realize pan-Arctic and global value-added services and provide societal benefits. Its goal is to enhance Arctic-wide observing activities by facilitating partnerships and synergies among existing observing and data networks ("building blocks"), and promoting sharing and synthesis of data and information. SAON also is committed to facilitating the inclusion of Arctic indigenous people in observing activities, in particular by promoting community-based monitoring efforts.

- SAON was initiated mostly by European science bureaucrats who felt that plans for developing an Observing Program as part of the 2007-2008 IPY represented a potential threat to the existing observations being made at the field stations they managed. Their response was to create SAON, in which the "sustaining" of any and all existing long-term observation programs was defined as the highest priority, independent of their relevance to climate change or to currently important science needs and questions. Some of the stations or observation programs were uniquely-designed or had been isolated for so long that they functioned poorly as a network. The original group has relaxed this view a bit, but there is still resistance to setting priorities other than data management, standardizing protocols, and maintenance of existing observations (which are all good things in their own right). Nonetheless, this approach has made defining new science needs and questions difficult and has hindered discussions of what coordinated set of observations might be more important, more useful, or more relevant than others.
- In 2016, the SAON Board convened an external review of the program's first 5 years. The review committee concluded that SAON is valued by the Arctic observing community but has yet to reach its full potential; they offered several recommendations in an [Executive Summary](#) and a [Full Report](#). The first main recommendation was to establish national SAON coordinating committees in each of the member nations (see below).

U.S. SAON (Now **U.S. AON**, see entry under IARPC). The first recommendation of the 2016 SAON external review was to establish national SAON Coordination Committees in each of the member nations. Accordingly, an outcome of the White House Ministerial meeting in September 2016 was the formation of a U.S. National SAON Committee (**USNSC**). Subsequently, the name of this committee has been changed to the **U.S. AON** committee, with an Advisory Board set up that is currently chaired by Sandy Starkweather (NOAA) and Will Ambrose (NSF).

EPB. The [European Polar Board](#) is an independent organisation that focuses on major strategic priorities in both the Arctic and Antarctic regions.

*Current EPB membership includes research institutes, funding agencies, scientific academies, and polar operators from across Europe. Since 2015, the EPB has been an independent entity, with its Secretariat hosted by the Netherlands Organisation for Scientific Research (NWO). Established in 1995, the EPB was an Expert Board of the European Science Foundation formed to provide strategic advice on Arctic and Antarctic issues. The EPB envisions a Europe with a **strong** and cohesive polar research community, wherein decisions affecting or affected by the polar regions are informed by **independent**, accurate, and timely advice from the EPB. The EPB has a mission to improve European **coordination** of Arctic and Antarctic research by optimising the use of European research infrastructure. We **promote** multilateral collaborations between our Members and provide a single contact point for the global polar research community. We **advance** the collective knowledge of polar issues, particularly in the context of European societal relevance.*

NORDECO. The [Nordic Agency for Development and Ecology](#) is a social enterprise wholly owned by the non-profit Nordic Foundation for Development and Ecology.

We conduct research, build capacity, connect people, and support interventions on-the-ground - and we do consulting in international development. How we are different:

- *We are wholly owned by a non-profit foundation*
- *Our skills range combines social and natural sciences*
- *We focus on delivering quality research and services that have an impact*
- *Our solutions are developed in close collaboration with local populations*
- *We regard society, culture and the environment as an integrated whole*
- *We work with all types of stakeholders at all levels – from global cooperation through national policy to local communities*

Global Observing Systems or Networks

WCRP. The [World Climate Research Program](#) is WCRP was established in 1980 under the joint sponsorship of the [International Council for Science \(ICSU\)](#) and the [World Meteorological Organization \(WMO\)](#), with the [Intergovernmental Oceanographic Commission \(IOC\)](#) of UNESCO joining as a sponsor in 1993.

The WCRP mission is to facilitate analysis and prediction of Earth system variability and change for use in an increasing range of practical applications of direct relevance, benefit and value to society. As part of this mission WCRP supports 4 core projects (including CliC and CLIVAR, see below), and has five Grand Challenges it supports through community organized workshops, conferences and strategic planning meetings to identify high priority and exciting research areas that require international partnership and coordination, and that yield “actionable information” for decision makers. The Grand Challenges are: (1) Clouds, Circulation and Climate Sensitivity, (2) Melting Ice and Global Consequences, (3) Climate Extremes, (4) Regional Sea-level Change and Coastal Impacts, and (5) Water Availability.

CLiC. The [Climate and Cryosphere](#) core project encourages and promotes research into the cryosphere in order to improve understanding of the cryosphere and its interactions with the global climate system and to enhance the ability to use parts of the cryosphere for detection of climate change. It works with 11 institutional partners (e.g., IASC) and its home is at the [Norwegian Polar Institute](#).

CLIVAR. The [Climate and Ocean Variability, Predictability and Change](#) is a core project whose mission is to understand the dynamics, the interaction, and the predictability of the coupled ocean-atmosphere system. To this end it facilitates observations, analysis and predictions of changes in the Earth's climate system, enabling better understanding of climate variability, predictability and change.

GCOS. The [Global Climate Observatory System](#) is a joint undertaking of the World Meteorological Organization ([WMO](#)), the Intergovernmental Oceanographic Commission ([IOC](#)) of the United Nations Educational Scientific and Cultural Organization ([UNESCO](#)), the United Nations Environment Programme ([UNEP](#)) and the International Council for Science ([ICSU](#)). GCOS supports several [Global Terrestrial Networks](#) including ones for glaciology and permafrost.

GCOS is intended to be a long-term, user-driven operational system capable of providing the comprehensive observations required for Monitoring the climate system, Detecting and attributing climate change, Assessing impacts of, and supporting adaptation to, climate variability and change, Application to national economic development, and Research to improve understanding, modelling and prediction of the climate system.

GTN-P. The [Global Terrestrial Network for Permafrost](#)
GTN-P monitors permafrost (borehole temperatures and active layer thickness) through ground-based, point measurements. Permafrost thermal state (i.e. ground temperature) and active layer thickness are the key permafrost variables identified as Essential Climate Variables (ECV) for monitoring under the GCOS/GTOS programs. GTN-P was approved in 1999 and coordinated by the [International Permafrost Association \(IPA\)](#), comprises two international monitoring networks: [Thermal State of Permafrost \(TSP\)](#) and [Circumpolar Active Layer Monitoring \(CALM\)](#). More than 20 countries participate in these networks.

GTN-G. The [Global Terrestrial Network for Glaciers](#)
GTN-G is a monitoring and observing network that provides data and information to the scientific community and to the wider public on the state of glaciers. GTN-G was developed by the GCOS/GTOS Terrestrial Observation Panel for Climate ([TOPC](#)) to design a global observing strategy and set in place a global network for monitoring glaciers and ice caps in the terrestrial domain in support of the United Nations Framework Convention on Climate Change ([UNFCCC](#)).

CEON. The [Circum-Arctic Environmental Observatories Network](#) was conceived of in 2002 by NSF Polar Programs and is supported by a variety of funding agencies worldwide.

CEON is a network of terrestrial and freshwater observation platforms, science experts and network partners promoting the collection and dissemination of environmental data from the Arctic. CEON observation platforms include land and freshwater observatories, research infrastructures, former research sites where retrospective analyses are being or can be undertaken, data and image archive centers and community monitoring programs. Current Activities include: (1) Transitioning from an implementation phase to becoming a fully implemented multi-laterally funded international network, (2) Developing documentation that formally identifies the network, its mission, objectives, scope and mode of operation, (3) Developing mechanisms and cyberinfrastructure for enhancing information transfer both within and external to CEON, and (4) Liaising with CEON stakeholders and reviewing current monitoring efforts and capacities at a circum-Arctic scale to identify partnerships, locations, mechanisms and technologies that could be implemented to reduce observational gaps in the Arctic.

SCANNET. This [Scandinavia Network](#) is a collaborative program of a network of field site leaders, research station managers and user groups in northern Scandinavia and Europe to improve comparative observations and access to information on environmental change in the North.

SCANNET partners provide stability for research and facilitating long-term observations in terrestrial and fresh water systems, and they provide information on existing environmental data sets and research activities from key locations in the SCANNET and North Atlantic Region. SCANNET links to related networks from local to global scales by providing a focus on the landscapes and environments of the North Atlantic Region.

INTERACT. The [International Network for Terrestrial Research and Monitoring in the Arctic](#) is an EU-funded project.

INTERACT is an infrastructure project under the auspices of SCANNET, a circumArctic network of currently 79 terrestrial field bases in northern Europe, Russia, US, Canada, Greenland, Iceland, the Faroe Islands and Scotland as well as stations in northern alpine areas. INTERACT specifically seeks to build capacity for research and monitoring in the European Arctic and beyond, and is offering access to numerous research stations through the [Transnational Access](#) program.

EU-PolarNet. The [EU-PolarNet](#) is a consortium of expertise and infrastructure for polar research, representing 22 research institutions from 17 European countries. From 2015-2020 it will work in cooperation with the [European Polar Board \(EPB\)](#) to deliver a framework and mechanisms to prioritise science, optimise the use of polar infrastructure, and broker new partnerships to co-design polar research projects that deliver tangible benefits for society.

*EU-PolarNet aims to improve co-ordination between EU member polar research institutions building on existing networks to create a resource orientated infrastructure access and usage plan. This plan would allow for the co-ordination of data and infrastructure between all the partner organisations. **EU-PolarNet** will develop an integrated EU Polar research programme by identifying short and long-term scientific needs and optimising the use of co-ordinated Polar infrastructure for multi-platform science missions whilst fostering trans-disciplinary collaboration on Polar research. **EU-PolarNet** will also create and sustain ongoing dialogue and co-operation with Polar stakeholders by supporting meaningful interaction to shape future research, exchange key information and foster joint involvement.*

GCW. The [Global Cryosphere Watch](#), and its core observing piece CryoNET, is an extensive initiative (~33 Institutional Partners) sponsored by the World Meteorological Organization (WMO), with a Steering Group and three Working Groups, each of which has one or more [Teams](#).

*The GCW is an international mechanism for supporting all key cryospheric in-situ and remote sensing observations. To meet the needs of WMO Members and partners in delivering services to users, the media, public, decision and policy makers, **GCW provides authoritative, clear, and useable data, information, and analyses on the past, current and future state of the cryosphere.** GCW includes observation, monitoring, assessment, product development, prediction, and research. It provides the framework for reliable, comprehensive, sustained observing of the cryosphere through a coordinated and integrated approach on national to global scales to deliver quality-assured global and regional products and services. GCW organizes analyses and assessments of the cryosphere to support science, decision-making and environmental policy. The observing component of GCW is a component of the WMO Integrated Global Observing System (WIGOS). Through WIGOS and the WMO Information System (WIS), GCW will provide a fundamental contribution to the Global Earth Observation System of Systems (GEOSS). GCW will organize analyses and assessments of the*

cryosphere to support science, decision-making, environmental policy and services through, inter alia, its foundational support to the Global Framework for Climate Services (GFCS).

IOOS. The [Integrated Ocean Observing System](#) is supported by [NOAA](#) as a national-regional partnership working to provide new tools and forecasts to improve safety, enhance the economy, and protect our environment. Integrated ocean information is available in near real time and retrospectively. The [Alaska Ocean Observing System](#) (AOOS) is contained within IOOS.

The vision of IOOS is to provide a fully integrated ocean observing system that enables the National Oceanic and Atmospheric Administration (NOAA) and its partners to provide service to the Nation through improved ecosystem and climate understanding; sustained living marine resources; improved public health and safety; reduced impacts of natural hazards and environmental changes; and enhanced support for marine commerce and transportation. The U.S. IOOS Program Office is organized into two divisions that implement policies, protocols, and standards to implement IOOS and oversee the daily operations and coordination of the System: (1) Operations Division and (2) Regions, Budget, and Policy.

GOOS. The [Global Ocean Observing System](#) is a program executed by the Intergovernmental Oceanographic Commission (IOC) of the UNESCO, and coordinates observations around the global ocean for three critical themes: **climate, ocean health, and real-time services**. These themes correspond to the GOOS mandate to contribute to the UNFCCC Convention on climate change, the UN convention on biodiversity and the IOC/WMO mandates to provide operational ocean services, respectively.

GOOS governance has three tiers: a multinational Steering Committee to provide oversight, scientific Expert Panels to guide system requirements, and Observation Coordination Groups that implement global unified network execution; the Project Office facilitates collaboration between these bodies. Three discipline-based [GOOS Expert Panels](#) provide scientific oversight on [Physics](#), [Biogeochemistry](#), and [Biology and Ecosystems](#). Expert Panels are central in the GOOS work structure, as they focus on the dispersed GOOS Networked observations, acting as a liaison and advocate for users and collaborators at local, national, and regional scales. [GOOS Regional Alliances \(GRAs\)](#) identify, enable, and develop sustained GOOS ocean monitoring and services to meet regional and national priorities, aligning the global goals of GOOS with the need for services and products satisfying local requirements. Networked Observations are coordinated by [JCOMM, the Joint Technical Commission for Oceanography and Marine Meteorology](#), which provides a mechanism for international coordination of oceanographic and marine meteorological observing, data management and services. Support for the in situ observing platform is provided by JCOMMOPS. System-based evaluations can lead to finite lifetime observing system [development projects](#). These projects often involve several expert panels and aim to either address an old system in need of renovation or a globally recognized scientific gap, thus increasing the readiness level of the observing system.

OOI. The [Ocean Observatories Initiative](#) is funded by NSF to enable multiple scales of marine observations integrated into one observing system. The infrastructure currently includes 89 platforms, 830 instruments, and 100,000 data products for use by the science community.

The OOI established a network of interactive, globally distributed sensors with near real-time data access, enhancing our capabilities to address critical issues such as climate change, ecosystem variability, ocean acidification, and carbon cycling. The design of the OOI enables multiple scales of marine observations integrated into one observing system via common design elements and overarching, interactive [Cyberinfrastructure Technology](#). The coastal assets of the OOI expand existing observations off both U.S. coasts, creating focused, configurable observing regions. Cabled observing platforms ‘wire’ a single region in the Northeast Pacific Ocean with a high speed optical and high power grid. And the global component addresses planetary-scale changes via moored open-ocean buoys linked to shore via satellite. The OOI is

funded by the National Science Foundation and is managed and coordinated by the OOI Program Office at the Consortium for Ocean Leadership (COL), in Washington, D.C. COL is leader, owner, and operator of the OOI and its infrastructure. Implementing Organizations (IOs), subcontractors to COL, are responsible for construction and development of the different components of the program.

PCN. The [Permafrost Carbon Network](#) was originally funded by the U.S. NSF and is now a part of the [Study of Environmental Arctic Change \(SEARCH\)](#), which continues to support activities developed by the Permafrost Carbon Network. The network has been successfully running since 2011 and includes more than 300 scientists from 88 research institutions located in 17 countries.

The Permafrost Carbon Network started in 2011 and our main objectives are to synthesize existing research about permafrost carbon and climate in a format that can be assimilated by biospheric and climate models, and that will contribute to future assessments of the Intergovernmental Panel on Climate Change (IPCC).

*Our **activities** include a series of **meetings** and working groups designed to synthesize ongoing permafrost carbon research which will produce new knowledge to quantify the role of permafrost carbon in driving climate change in the 21st century and beyond.*

IASOA. The [International Arctic Systems for Observing the Atmosphere](#) is a NOAA-funded group that currently coordinates 10 Arctic observatories.

The mission of IASOA is to advance coordinated and collaborative research objectives from independent pan-Arctic atmospheric observatories through (1) strategically developing comprehensive observational capacity, (2) facilitating data access and usability through a single gateway, and (3) mobilizing contributions to synergistic science and socially-relevant services derived from IASOA assets and expertise.

Specific or Regional Programs and Projects

ISAC. The [International Study of Arctic Change](#) was initiated in 2003 by IASC and the [Arctic Ocean Sciences Board](#), following the SEARCH open science meeting in October 2003. ISAC is presently supported by the Arctic Institute of North America, Calgary.

ISAC is an open-ended, international, interdisciplinary Arctic environmental change program, designed to provide timely, relevant, and accessible scientific information for responding to rapid change in circumpolar regions. ISAC will provide the international framework for a comprehensive study of Arctic environmental change with all its physical, biogeochemical, ecological, and human dimensions. ISAC requires observation and tracking of shifting Arctic conditions, processes and ecosystems, understanding of the nature and drivers of such changes, and building knowledge on the feedbacks, interconnections and impacts within and beyond polar regions. ISAC encompasses pan-Arctic, system-scale, multidisciplinary observations, synthesis and modelling to provide an integrated understanding of Arctic change and projections of future change. The [ISAC Science Plan](#) provides a vision for integrating research and applications among diverse fields and varied users and stakeholders. ISAC is motivated by environmental changes that are already large enough to affect life for Northern communities, biodiversity, ecosystems, and regions within and outside the Arctic that need to develop strategies for adapting to and managing a changing Arctic.

- Note that ISAC has adopted the three broad activities of Observing, Understanding, and Responding to change that was originally put forth in the SEARCH 2005 report that led to NSF funding the Arctic [Observing Network \(AON\)](#), the first of those three activities. Their [Science Plan](#) is quite detailed and useful.

MOSAIC. The [Multidisciplinary drifting Observatory for the study of Arctic Climate](#) is a project under the auspices of IASC and to be funded by a consortium of research institutions for 5 years (2016-2021, €60M); view the [Science Plan](#).

*The results of MOSAiC will contribute to enhanced understanding of the regional and global consequences of Arctic climate change and sea-ice loss and improve weather and climate predictions. As such it will support safer maritime and offshore operations, contribute to an improved scientific basis for future fishery and traffic along northern sea routes, increase coastal-community resilience, and support science-informed decision-making and policy development. The focus of MOSAiC lies on direct in-situ observations of the climate processes that couple the **atmosphere, ocean, sea ice, bio-geochemistry and ecosystem**.*

INTAROS. The [Integrated Arctic Observing System](#) is a project funded by the European Commission for 5 years (2016-2021, €15.5M) with 49 partners from 20 countries.

INTAROS will develop an integrated Arctic Observation System (iAOS) by extending, improving and unifying existing systems in the different regions of the Arctic, integrating data from atmosphere, ocean, cryosphere and terrestrial sciences. Satellite data will therefore be integrated into iAOS based on existing products and databases. In situ observing systems are much more limited due to logistical constraints and cost limitations, and thus represent the largest gap in the overall observing system. INTAROS will assess strengths and weaknesses of existing observing systems and contribute with innovative solutions to fill critical gaps in the network. The iAOS platform will search for and access data from distributed databases. The evolution into a sustainable Arctic observing system requires coordination, mobilization and cooperation between the existing European and international infrastructures (in-situ and remote including space-based), the modeling communities and relevant stakeholder groups. INTAROS will include development of community-based observing systems, merging local knowledge with scientific data, to strengthen the societal and economic role of the Arctic and support the EU strategy for the Arctic and related maritime and environmental policies.

INTAROS will support the implementation of the EU's [Arctic Policy](#). The first ever Arctic science ministerial was held in 2016 and concluded in a Joint statement on increased international collaboration on Arctic science, signed by 25 nations and the European Union.

Specific Objectives:

- 1:** Establish a Pan-Arctic forum to support formulation of agreements and collaboration between organization involved in developing Arctic observing systems across EU member states, non-EU countries and transnational organizations.
- 2:** Develop a Roadmap for future implementation of a Sustainable Arctic Observing System.
- 3:** Exploit existing observing systems and databases of atmosphere, ocean, cryosphere, geosphere and terrestrial data as the backbone of an integrated Arctic Observing System (iAOS) platform.
- 4:** Contribute to fill gaps of the in situ observing system by use of robust technologies suitable for the Arctic.
- 5:** Add value to observations through assimilation into models.
- 6:** Enhance community-based observing programmes by building capacity of scientists and community members to participate in community based research.
- 7:** Develop and implement the iAOS platform for integration and analysis of multidisciplinary with distributed data repositories.
- 8:** Demonstrate benefit of the iAOS functionality to selected stakeholders.
- 9:** Develop professional skills in using the iAOS platform and new data products within industry, education and science.

DBO. The [Distributed Biological Observatory](#) is a NOAA-funded program to link physics and biology in the Bering, Beaufort, and Chukchi Seas.

DBO sites are regional "hotspot" transect lines and stations located along a latitudinal gradient considered to exhibit high productivity, biodiversity, and overall rates of change. DBO sites will serve as a change detection

array for the identification and consistent monitoring of biophysical responses, and be occupied by national and international entities with shared data plan.

LCC. The [Landscape Conservation Cooperatives](#) are funded by the U.S. Department of Interior and form a network of 22 sites, including three in [Alaska](#), to integrate science and management to address climate change and other landscape-scale issues.

LCCs are building a network that is holistic, collaborative, adaptive, and grounded in science to ensure the sustainability of our economy, land, water, wildlife, and cultural resources. The 22 LCCs collectively form a network of resource managers and scientists who share a common need for scientific information and interest in conservation. Each LCC brings together federal, state, and local governments along with Tribes and First Nations, non-governmental organizations, universities, and interested public and private organizations. Our partners work collaboratively to identify best practices, connect efforts, identify science gaps, and avoid duplication through conservation planning and design.

CONAS. The [Community Observation Network for Adaptation and Security](#) began in 2014.

CONAS builds on the prior Bering Sea Sub-Network project (BSSN), and consists of systematic observations made by subsistence hunters, fishermen and elders from eight communities around the Bering Sea. This information, which is owned and controlled by the communities, is then used to generate dynamic maps and data products that both residents and policy-makers can use to best inform decisions for a rapidly changing Arctic environment.

SIOS. The [Svalbard Integrated Arctic Earth Observatory System](#) is one of 21 international research infrastructure projects included in the Roadmap of the European Strategy Forum on Research Infrastructures ([ESFRI](#)), funded by the EU.

SIOS is a regional observing system for long-term measurements in and around Svalbard addressing Earth System Science questions; it will go into operational phase in 2018. SIOS integrates the existing distributed observational infrastructure and generates added value for all partners beyond what their individual capacities can provide.

BLUE ACTION. The [BLUE ACTION](#) program is an EU Horizon 2020 project on the Arctic Impact on weather and climate.

"Blue-Action: Arctic Impact on Weather and Climate" contributes to the implementation of the [Trans-Atlantic Ocean Research Alliance](#) and to the [EU's Blue Growth Agenda](#) and its long term strategy to support sustainable growth in the marine and maritime sectors as a whole. Our project is funded by the EU Horizon 2020 Programme and specifically by the [Blue-Growth BG-10-2016 call](#) "Impact of Arctic changes on the weather and climate of the Northern Hemisphere". Blue-Action supports the implementation of the [Galway](#) and the [Belem Statements](#) and the achievement of the [SDG8,9,13](#).

APPLICATE. The [APPLICATE](#) program is an EU Horizon 2020 project studying Arctic's connections to weather and climate in Europe, Asia, and North America.

The overarching goal of APPLICATE is to develop enhanced predictive capacity for weather and climate in the Arctic and beyond, and to determine the influence of Arctic climate change on Northern Hemisphere mid-latitudes, for the benefit of policy makers, businesses and society.

To achieve its mission, APPLICATE will address the following 7 top-level objectives:

- *Observationally constrain models using advanced metrics and diagnostics*

- *Develop enhanced weather and climate models*
- *Determine the impact of Arctic climate change on mid latitudes through atmospheric and oceanic linkages*
- *Contribute to the design of the future Arctic observing system*
- *Enhance the capacity to predict Northern Hemisphere weather and climate*
- *Develop and implement APPLICATE's research programme in coordination with external scientific partners to exploit synergies*
- *Transfer the knowledge generated through APPLICATE to stakeholders including training of early career scientists*

SIOS. The [Svalbard Integrated Arctic Earth Observing System](#) is an international observing system for long-term measurements in and around the Norwegian Archipelago of Svalbard addressing Earth System Science.

SIOS is a regional observing system for long-term measurements in and around Svalbard addressing Earth System Science questions. SIOS integrates the existing distributed observational infrastructure and generates added value for all partners beyond what their individual capacities can provide. SIOS brings observations together into a coherent and integrated observational programme that will be sustained over a long period. Within SIOS, researchers can cooperate to access instruments, acquire data and address questions that would not be practical or cost effective for a single institution or nation alone. SIOS focuses on processes and their interactions between the different spheres, i.e. biosphere, geosphere, atmosphere, cryosphere and hydrosphere. The core observational programme of SIOS provides the research community with systematic observations that are sustained over time, yet dynamic enough to be adapted as new methods and questions from society appear.

ICE-ARC. The [ICE-ARC](#) is an EU FP7 project directly assessing the social and economic impact of Arctic sea-ice loss.

ICE-ARC (Ice, Climate, Economics – Arctic Research on Change) will look into the current and future changes in Arctic sea ice – both from changing atmospheric and oceanic conditions. The project will also investigate the consequences of these changes both on the economics of the area and globally, and social aspects such as on indigenous peoples. The four year project brings together physicists, chemists, biologists, economists, and sociologists from 21 institutes from 11 countries across Europe. With a budget of €11.5M we aim to understand and quantify the multiple stresses involved in the change in the Arctic marine environment. Particular focus is on the rapid retreat and collapse of Arctic sea-ice cover. The outcome of the project will be a better understanding of, and ability to predict, Arctic marine change. This will provide an improvement in the scientific baseline for guiding EU and international policies on the protection of the Arctic marine environment, at a time of increased socio-economic pressure, especially in the field of resource exploitation.

PEEX. The [PEEX](#) is a "Pan-Eurasian Experiment" multidisciplinary study of climate change, air quality, environment and research infrastructure program focused on the Northern Eurasian particularly arctic and boreal regions.

The PEEX program agenda is divided into four focus areas: 1. Research agenda, 2. Infrastructures, 3. Impact on society and 4. Knowledge Transfer (PEEX Science Plan). Overall it is a bottom up initiative by several European, Russian and Chinese research organizations and institutes.

RUSALCA. The [Russian-American Long-Term Census of the Arctic](#) is an MOU between NOAA and the Russian Academy of Sciences to cooperate on joint ocean expeditions of research, census, and exploration. The first joint expedition was in 2003, and the latest was in 2015. The U.S. program resides in NOAA's [Office of Ocean Exploration and Research](#).

Government-sponsored Groups

PRB. U.S. [Polar Research Board](#) was established in 1958 and is part of the U.S. National Academy of Sciences.

The Polar Research Board (PRB) exists to promote excellence in polar science and to provide independent scientific guidance to federal agencies and the nation on science issues in the Arctic, the Antarctic, and cold regions in general. The PRB strives to: (1) make research in the polar regions more productive and responsive to the needs of the United States,(2) maintain U.S. awareness of and representation in international science programs, and (3) enhance understanding of issues in polar regions. 2018.

USARC. The U.S. [Arctic Research Commission](#) was created by the Arctic Research Policy Act of 1984 and is an independent agency that advises the President and Congress on domestic and international Arctic research through recommendations and reports.

The Commission's principal duties are (1) to establish the national policy, priorities, and goals necessary to construct a federal program plan for basic and applied scientific research with respect to the Arctic, including natural resources and materials, physical, biological and health sciences, and social and behavioral sciences; (2) to promote Arctic research, to recommend Arctic research policy, and to communicate our research and policy recommendations to the President and the Congress; (3) to work with the [National Science and Technology Council](#) (as per [Presidential Memorandum](#) and [White House guidance](#)) and the [National Science Foundation](#) as the lead agency responsible for implementing the Arctic research policy and to support cooperation and collaboration throughout the Federal Government; (4) to give guidance to the [Interagency Arctic Research Policy Committee \(IARPC\)](#) to develop national Arctic research projects and a five-year plan to implement those projects; and (5) to interact with Arctic residents, international Arctic research programs and organizations and local institutions including regional governments in order to obtain the broadest possible view of Arctic research needs.

ARCUS. The [Arctic Research Consortium of the U.S.](#) is a nonprofit organization supported by NSF to advance Arctic research and education. They maintain a current calendar of meetings and events and provide meeting support to SEARCH, SIPN, and other research efforts.

ARCUS was formed in 1988 to identify and bring together the distributed human and facilities resources of the Arctic research community—to create a synergy for the Arctic in which each resource, when combined with others, can result in a strength that enables the community to rise to the many challenges facing the Arctic. ARCUS members join in a common purpose of advancing knowledge of the Arctic through science, technology, indigenous knowledge, and other forms of knowing; promoting the application of this knowledge to circumpolar Arctic problems; and addressing in concert those questions that require the collaborative skills and resources of scientists, engineers, indigenous knowledge holders, and others throughout the world. ARCUS provides a mechanism for the Arctic community to complement the advisory roles of other national organizations that are concerned with the Arctic, such as the U.S. Arctic Research Commission (USARC), the Polar Research Board (PRB), and the Interagency Arctic Research Policy Committee (IARPC). ARCUS collaborates with international Arctic organizations, such as the International Arctic Science Committee (IASC), the Arctic Council and its scientific working groups, and the Association for Polar Early Career Scientists (APECS).

Arctic Science Ministerial. The first ever [White House Arctic Science Ministerial](#) (WHASM) meeting was held in [September 2016](#) at the White House.

The White House Arctic Science Ministerial brought together ministers of science, chief science advisors, and other high-level officials from countries around the world, as well as representatives from indigenous groups, to expand joint collaborations focused on Arctic science, research, observations, monitoring, and data-sharing.

The goals of the event were to advance promising, near-term science initiatives and create a context for increased international scientific collaboration on the Arctic over the longer term.

Data Networks, Management Sites, Portals

NSIDC. The [National Snow and Ice Data Center](#) supports research into snow, ice, glaciers, frozen ground, and climate interactions that make up Earth's cryosphere. It is supported by NASA, NSF, NOAA, and other agencies.

NSIDC manages and distributes scientific data, creates tools for data access, supports data users, performs scientific research, and educates the public about the cryosphere. NSIDC's research and scientific data management activities are supported by NASA, the National Science Foundation (NSF), the National Oceanic and Atmospheric Administration (NOAA), and other federal agencies, through competitive grants and contracts.

ADC. The [Arctic Data Center](#) is the primary data and software repository for the Arctic section of NSF Polar Programs. The ADC project (\$5.9M) replaces the CADIS and [ACADIS](#) database projects, although an ACADIS section still resides on the NSIDC site.

The NSF Arctic Data Center will help the research community reproducibly [preserve](#) and discover all products of NSF-funded science in the Arctic, including data, metadata, software, documents, and provenance that link these in a coherent knowledge model. Key to the initiative is the partnership between [NCEAS](#) at UC Santa Barbara, [DataONE](#), and NOAA's [NCEI](#), each of which bring critical capabilities to the Center. Infrastructure from the successful NSF-sponsored DataONE federation of data repositories will enable data replication to NCEI, providing both offsite and institutional diversity that is critical to long term preservation.

DataONE. [DataONE](#) is a Data Observation Network supported by NSF, and serves as the foundation of new innovative environmental science through a distributed framework and sustainable cyberinfrastructure that meets the needs of science and society for open, persistent, robust, and secure access to well-described and easily discovered Earth observational data.

DataONE is supported by NSF (Phase 1 Grant #ACI-0830944, Phase 2 Grant #ACI-1430508), and as one of the initial DataNets, DataONE will ensure the preservation, access, use and reuse of multi-scale, multi-discipline, and multi-national science data via three primary cyberinfrastructure elements and a broad education and outreach program.

Arctic Portal. The [Arctic Portal](#) is operated in consultation with the Arctic Council and other stakeholders and operated as a non-profit organization in Iceland under an international board of directors. It hosts or manages a variety of data bases such as the [Arctic Coastal Dynamics](#) (ACD) and the [Arctic Hydrological Cycle Monitoring, Modeling, and Assessment](#) Program (Arctic-HYDRA)

The Arctic Portal is a comprehensive gateway to Arctic information and data on the internet, increasing information sharing and co-operation among Arctic stakeholders and granting exposure to Arctic related information and data. It is a network of information and data sharing and serves as host to many web sites in a circumpolar context, supporting co-operation and outreach in science, education, and policy making. The Arctic Portal provides web presence to over 50 scientific institutions, associations and projects of international importance, and participates in Arctic research projects such as European Commission funded EU Arctic Information Centre Initiative, Arctic Council SDWG endorsed [Arctic Maritime and Aviation Transportation Infrastructure Initiative](#), the [Arctic Council SAON project](#), the EU 7th framework program funded [PAGE21 Permafrost project](#) and many others.

Arctic-Hub. The [Arctic-Hub](#) is a portal for Arctic news, events, and jobs, and hosts an open source platform for scientific and educational collaboration for people interested in Arctic Observation, including the international effort for the Arctic Observing Assessment (AOA, sponsored by SAON).

The Arctic Observing Assessment (AOA) is an international effort under the auspices of the Sustaining Arctic Observing Networks and the Interagency Arctic Research Policy Committee to document and visualize available scientific information relevant to Arctic priorities to measure the relevance of current observing capabilities to user needs. This living assessment and online resource looks at the interrelationships between available environmental, socio-economic and well-being observations, allowing complex user-defined searches and graphical representation of our strengths and needs for observing in the Arctic.

Polar Commons. The [Polar Commons](#) is an international non-profit organization committed to providing information about a wide range of issues concerning the polar regions.

Our mission is to inform and educate the public by providing access to facts, figures and data with a focus on the impact of human activities on the polar regions as well as offering access to the latest scientific discoveries, findings and insights into the changes in the Arctic and AntArctica. By pointing out to the consequences of these changes not only for the environment and wildlife in the polar regions but for the entire world, we hope to attract the attention of the wider public and to prompt action. The end goal is to form an international movement that would create pressure on governments, corporations and other institutions with the power to make a difference at both national and international levels.

PIC. The [Polar International Circle](#) is an information and data exchange program developed by Polar Commons to help both the scientific community and the public to access relevant, reliable, and current information and data on a wide range of issues concerning the Earth's polar regions.

PIC was built for Polar Commons by a software programming and development company to meet the highest security standards, enable fast and easy exchange of information and ideas, and at the same time, meet Polar Commons' strict set of rules in regard to ethics and norms. To promote cooperation and data sharing, PIC also features Alert function that alerts users when new data/information is shared to help members of the community to stay up-to-date with the latest findings and developments.

DATA.GOV. The [DATA.GOV](#) site is the U.S. Government site for all data, from agriculture to finance to health to climate. Within the [Climate section](#) there is an [Arctic section](#).

Data.gov is managed and hosted by the U.S. General Services Administration, [Technology Transformation Service](#), is powered by two open source applications, [CKAN](#) and [WordPress](#), and is developed publicly on [GitHub](#). Data.gov follows the [Project Open Data schema](#) – a set of required fields (Title, Description, Tags, Last Update, Publisher, Contact Name, etc.) for every data set displayed on Data.gov.

EDI. The [Environmental Data Initiative](#) is an NSF-funded project that will subsume the current, individual NSF-LTER, OBFS, and MSB databases.

EDI is meant to accelerate curation and archive of environmental data, emphasizing data from projects funded by the NSF DEB. Programs served include Long Term Research in Environmental Biology (LTREB), Organization for Biological Field Stations (OBFS), Macrosystems Biology (MSB), and Long Term Ecological Research (LTER).

NCEI. The [National Centers for Environmental Information](#) is funded by NOAA and includes a regional data center in Anchorage.

NCEI hosts and provides access to one of the most significant archives on earth, with comprehensive oceanic, atmospheric, and geophysical data. From the depths of the ocean to the surface of the sun and from million-year-old ice core records to near-real-time satellite images, NCEI is the Nation's leading authority for environmental information. By preserving, stewarding, and maximizing the utility of the Federal government's billion-dollar investment in high-quality environmental data, NCEI remains committed to providing products and services to private industry and businesses, local to international governments, academia, as well as the general public.

Select Past Programs and Projects

IPY. The [International Polar Year](#)

The International Polar Year is a large scientific program focused on the Arctic and the Antarctic from March 2007 to March 2009. IPYs are organized through the International Council for Science (ICSU) and the World Meteorological Organization (WMO) and were previously held in 1882-3, 1932-3, and 1957-8.

DAMOCLES. The project [DAMOCLES](#) (Developing Arctic Modeling and Observing Capabilities for Long-term Environmental Studies) ended in 2010. It was an integrated ice-atmosphere-ocean monitoring and forecasting system designed for observing, understanding and quantifying climate changes in the Arctic. DAMOCLES was specifically concerned with the potential for a significantly reduced sea ice cover, and the impacts this might have on the environment and on human activities, both regionally and globally.

ACCESS. The project [ACCESS](#) (Arctic Climate Change, Economy and Society) was supported by the European Commission from 2011-2015 (€11M, 9 European countries plus Russia). Its main objective is to assess climatic change impacts on marine transportation (including tourism), fisheries, marine mammals, and the extraction of oil and gas in the Arctic Ocean. ACCESS is also focusing on Arctic governance and strategic policy options. See the ACCESS [Deliverables](#).

History of Arctic Science Observing in the U.S.

The foundation for modern scientific observations and observing programs in the U.S. Arctic was built in 1947 when the Arctic Research Laboratory (later the Naval Arctic Research Laboratory, NARL) was established at Barrow, Alaska. Funded by the Office of Naval Research (ONR), studies at NARL included observations of terrestrial, freshwater, marine, and atmospheric systems. About 25 years later, using NARL facilities and patterned after the successful International Geophysical Year of 1957-58, the International Biological Programme ([IBP](#)) included a site at Barrow that was funded by NSF from 1971 to 1973. The main IBP themes presaged current topics of interests, including building a global database for modeling and comparison, and using environmental knowledge to address problems of degradation, maintenance, and restoration of ecosystems.

The end of the IBP project in 1974 coincided with the opening of the Dalton Highway, the Fairbanks to Prudhoe supply route for the oil fields, which provided new access to inland tundra ecosystems on the North Slope of Alaska. In 1975, research supported by the NSF Division of Polar Programs began

at Toolik Lake and grew to include aquatic and terrestrial studies. What was special about this research was the unstated yet realized long-term funding support from NSF, which allowed consistent observations of tundra ecosystems to be made for well over a decade. The usefulness and indeed necessity of such long-term observations was increasingly recognized and led to the creation of the [LTER](#) program (Long-Term Ecological Research) in 1980, the first NSF program specifically designed with stability in funding to allow for monitoring and measurements over long time scales (decades); this is essentially the “sustained observing” that is needed in the Arctic.

The Arctic LTER project at Toolik Lake was funded in 1987 to study streams, lakes, and tundra (refunded, 2017-2022). There are two key aspects of the LTER relevant to Arctic science and observing programs. First, starting with the LTER, the funding support from NSF for the Toolik Lake field station has grown to the point that it is the premiere field site for U.S. Arctic research, now hosting both environmental and geophysical studies. Second, the LTER program at NSF provides a template for operating a network of 26 sites where long-term observations and network coordination is accomplished, even within the guiding NSF framework of funding short-term (2-5 year), curiosity-driven research grants.

As the coordinated, large-scale LTER network was growing, in 1990 Polar Programs at NSF created Arctic System Science ([ARCSS](#)), which was an outgrowth of the International Geosphere-Biosphere Program ([IGBP](#)) and was designed to document and understand processes of the Arctic system that interact with the total Earth system. ARCSS encompassed and funded several programs including Paleoclimate of Arctic Lakes and Estuaries (PALE), Land-Air-Ice Interactions (LAII), and Ocean-Air-Ice Interactions (OAI). The first NSF award competition in these programs was the ARCSS Flux-LAII Study (funded in 1993), followed by the Surface Heat Budget of the Arctic Ocean ([SHEBA](#)) in 1997. Results from these very large, longer-term, multi-investigator projects funded by NSF helped the science community realize that the Arctic system was changing substantially, and there was a need for more synoptic observations of change in time and space. In other words, projects like SHEBA were at the forefront of developing process-level understanding, but we needed a network of observations designed to support longer-term studies and answer new questions about how and how fast the Arctic was changing.

A series of workshops and reports on Arctic change in the late 1990s and early 2000s (see the [ARCUS website](#)) culminated in a [2005 report](#) from SEARCH that created an Observing Change Panel (OCP), which highlighted the urgent need for improved coordination and integration of sustained Arctic observing programs worldwide. In response to this SEARCH report, NSF established the first major U.S. observing program with the Arctic Observing Network (AON) in 2006. One idea discussed at this meeting was for NSF to fund a series of studies, first on “Observing Change (AON)”, followed by “Understanding Change”, and “Responding to Change.” Unfortunately, only the Observing Change program has been funded, and there is little or no programmatic integration across the intellectual landscape of observing, understanding, and responding to change. For example, as originally implemented, AON would not fund projects that analyzed observations. Rather, AON was used only to fund observations with the idea that community members would use the data for separately supported analyses. That limitation has now been lifted, and AON accepts proposals for observations coupled to analyses.

Once AON was established by NSF, it was more generally recognized that in fact several U.S. agencies (e.g., NOAA, NASA, ONR, DOE) were conducting studies and observations in the Arctic.

To help coordinate these agency efforts in the Arctic, the U.S. IARPC formed the [Arctic Observing System](#) (AOS) program in 2008. IARPC gained new strength in 2010 when it was chartered by the White House as a subcommittee under the NSTC (U.S. [National Science and Technology Council](#)). While IARPC is not a funding agency, it helps to coordinate many U.S. funding agencies, it provides reports on Arctic research priorities, and it has the potential to coordinate joint funding calls from several agencies for Arctic observing.

Most recently, the 2016 Arctic Observing Summit and the first White House Arctic Science Ministerial (WHASM) recommended that the international Sustaining Arctic Observing Networks program (SAON) should lead both planning and implementation of a coordinated Arctic observing system. SAON is a joint initiative of the Arctic Council (AC) and the International Arctic Science Committee (IASC) and, as such, brings both Arctic and non-Arctic nations to the table. An outcome of WHASM was the establishment of a U.S. National SAON Committee (USNSC) in support of broader SAON goals but in particular to help transform SAON at the international level from a planning into an implementing body. This U.S. committee has been renamed as the U.S. AON committee that resides in the IARPC structure.

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