Arctic Challenge for Sustainability II

Towards a New Horizon of Arctic Research
We will promote advanced and interdisciplinary research on the Arctic, aiming for the social implementation of the results.

Project Overview – About ArCS II

The Arctic Challenge for Sustainability II (ArCS II) is a national flagship project for Arctic research and a successor to the Arctic Challenge for Sustainability (ArCS) project that operated from fiscal 2015 to 2019. The project will take place over approximately four and a half years, from June 2020 to March 2025, primarily through the collaboration of three institutions: the National Institute of Polar Research (NIPR), the Japan Agency for Marine-Earth Science and Technology (JAMSTEC), and Hokkaido University. Aiming to foster the realization of a sustainable society, the ArCS II project will promote advanced research to understand the current status and process of environmental changes in the Arctic and to improve meteorological and climate prediction in order to assess the impact of rapid environmental changes in the Arctic on human society, including Japan, as well as to implement the results of this research into society. We also provide domestic and international stakeholders with our scientific knowledge that will be a basis for legal and policy for the formation of international rules in the Arctic.

Background of Project

The Arctic region is where the impact of global warming is most evident. Scientific evidence indicates that rapid changes in the natural environment of the Arctic region, such as a rapid reduction in sea ice and accelerated ice sheet melting, are having a significant impact on the environment and ecosystems - not only in the Arctic, but across the entire planet - and serious concerns for the future have been shared on an international level. Conversely, the decline in Arctic sea ice is expected to lead to a dramatic expansion in economic activity through the utilization of Arctic sea routes and the development of seabed resources - a matter of great interest not only to Arctic nations but also to many non-Arctic nations. However, expansion of economic activity, including sea route and seabed resource development, risks not only causing irreversible damage to the Arctic environment and ecosystems, which are highly fragile, but also accelerating environmental changes on a global scale.

The Arctic research projects conducted by Japan thus far have elucidated some of the mechanisms for amplification of Arctic warming and its impact on the planet, and have helped deliver scientific findings to key stakeholders. These projects have also identified that the Arctic is a fragile, finely balanced environment, and that any changes trigger a complex chain of consequences. However, as the regions observed and data obtained are still limited, international cooperation is needed to eliminate this “vacuum” in observation and achieve a more accurate understanding of the actual status and refine future prediction models.

There is a pressing international need to accurately understand the impact of changes in the Arctic environment on societal activity from not only a local perspective - including the rights of indigenous peoples and resource development and use - but also from a global perspective, and to develop measures in response. In order to tackle issues in the Arctic region, there is a strong international need for holistic research that integrates initiatives to strengthen international scientific cooperation, including participation by non-Arctic countries, with efforts to ensure that international legal and policy order in the Arctic is maintained.
Towards a Sustainable Society

4 Strategic Goals

In ArCS II, interdisciplinary research collaboration is a key strategy. Under four Strategic Goals, 11 Research Programs - including natural sciences, engineering, humanities, and social sciences - will collaborate to understand the actual situation and process of environmental change in the Arctic, to quantitatively predict its impact, and to study countermeasures with the aim of achieving integrated results.
For Accurate Scientific Understanding of the Arctic Environment

Arctic warming influences not only the Arctic region but also the entire globe. However, the actual state and processes of the various changes in the Arctic environment due to global warming have not yet been understood sufficiently. Hence, there is still a lack of the accurate information that provides a basis for measures such as assessment reports. The lack of scientific knowledge is also related to uncertainties in future predictions. In order to accurately understand Arctic environmental changes, it is necessary to conduct observations using advanced instruments in the Arctic wide-area and long-term research activities based on international cooperation.

Four Research Programs based on Field Observations

Strategic Goal 1 consists of four research programs in the fields: Atmosphere, Ocean, Cryosphere, and Land. We will conduct field observations with the aim of understanding the actual state of environmental changes.

- The atmospheric research program aims to understand the behaviors and sources of black carbon and various other aerosols (anthropogenic and natural aerosols) in the Arctic and their impacts on radiation and clouds. This program also aims to understand and quantify the behaviors and sources/sinks of greenhouse gases (GHGs) by measuring their concentrations and isotope ratios and performing numerical modeling.

- The ocean research program's goal is to elucidate the transport processes of water masses originating from the North Pacific and North Atlantic Oceans, respectively, by combining comprehensive observation methods and pan-Arctic sea ice–ocean modeling. This program also aims to clarify the marine environment in the marginal and multi-year ice zones that have been difficult to access.

- In the cryosphere research program, field observation, satellite observation, and numerical modeling will be conducted in the Greenland Ice Sheet as the primary target area to quantify the change in surface mass balance and to elucidate the past warmings and their environmental impacts. This program will also assess the effects of aerosols emitted from the seasonal sea ice area around the Greenland coast on the atmospheric chemical environment and cloud-formation processes.

- The land research program aims to identify the response of biodiversity to global warming through field observations in the high-latitude tundra. The program also aims to identify the forest-permafrost interaction and elucidate the dynamics of the pan-Arctic terrestrial ecosystems and GHGs based on the long-term observations of the boreal forests. Furthermore, field observations and regional climate modeling will be conducted to understand the environmental changes in the permafrost and periglacial regions.

Wide-area Observations from an Advanced and Long-term Perspective

The distinctive feature of Strategic Goal 1 is its focus on systematic and wide-area observations from an advanced and long-term perspective. In the atmosphere research program, it is expected to reduce uncertainties in Arctic climate prediction by quantifying the actual state of Arctic warming and interaction between atmospheric pollutants and cloud microphysics. The ocean research program will contribute to the conservation and sustainable use of fish stock as well as ecosystem-based fishery resource management. The program also contributes to improving sea ice–ocean forecasts and navigation support along the Northern Sea Route. Research on the Greenland Ice Sheet by the cryosphere research program is expected to improve knowledge on the global influence of Arctic warming such as sea-level rise. The land research program aims to elucidate the cycle of substances such as greenhouse gases, with attention to the structure and function of the Arctic ecosystem.
For Accurate Weather and Climate Prediction

The Arctic environment is undergoing rapid change amidst global warming. This impact is spreading outside the Arctic, leading to an increase in extreme events in mid-latitude areas. The need for accurate weather and climate prediction is growing, including for adaptation to environmental changes in the Arctic, to prepare for disasters caused by extreme events outside the Arctic region, and to evaluate the economic benefits of Arctic utilization and development. Additionally, obtaining a perspective regarding the potential of long-term, irreversible climate changes caused by shifts in the Arctic environment is essential in order to consider the future of the global environment and human society.

To respond to these needs, it is firstly necessary to scientifically elucidate how the Arctic environment formation came to be as it is today as well as its change mechanisms, and to study how these are related to weather and climate in regions outside the Arctic. Secondly, in addition to developing numerical models to express the related processes in precise detail, we need to use these numeric climate models to develop methods for predicting weather and climate-related phenomena on a range of time scales, as well as organize the relevant data. In our research to elucidate the mechanisms of climate change related to the Arctic region and its prediction, the key requirement at the present stage is to maintain a clear awareness of how these scientific findings can be applied to disaster prevention and adaptation on a range of time scales, and to link these to new prediction methods and new means to provide forecast information.

Towards Adaptation to Climate Change

The distinctive feature of Strategic Goal 2 is that we aim to achieve more reliable weather and climate prediction, over a greater time span than previously. This will allow us to assess the current state and analyze the causes of ongoing climate change in the Arctic region and associated extreme events, helping us to obtain a clearer picture of the future perspective. By providing data on environmental changes to local residents and governments in the Arctic region, we will contribute to the formulation of climate change adaptation measures. Additionally, assessing the current state and analyzing the causes of Arctic-derived climate change and extreme events in the mid-latitude regions, especially Japan, will allow us to present information related to daily weather forecasts, short-to-mid-term climate prediction and the long-term climate change perspective with a higher level of reliability than in the past. This will allow Japan to prepare practical disaster preparation and adaptation measures against Arctic-derived extreme events, and we hope that these findings will help deepen understanding of the impact of the Arctic region on Japan's weather and climate among the country's citizens.
The Impact of Arctic Environmental Change on Society

The rapid environmental changes in the Arctic region not only increase the risk of natural disasters due to permafrost thaw and increasing glacier discharge, but are also significantly impacting the lives of residents, particularly the traditional lifestyles of indigenous peoples. On the other hand, warming climate also has some positive aspects for human activity in the Arctic, including easier access to underground/submarine resources and vessel operation across the Arctic ocean. Despite its importance, compared to research into climate and environmental changes, research related to the societal impacts of these changes is still in the early stages.

Against this backdrop, understanding the impact of natural environmental changes in the Arctic on human society is an important and urgent task for the Arctic research community. Such social impacts are wide-ranging including natural disasters, resource use, and impact on livelihoods and traditional culture. We tackle this complex problem based on research findings and collaborative framework between the natural and social sciences that Japan has obtained through the GRENE-Arctic/ArCS Projects. Furthermore, by utilizing Japan's strengths in engineering knowledge and technology, our findings lead to proposals for measures to mitigate and respond to these impacts.

Collaborations among Natural Sciences, Social Sciences and Engineering

In Strategic Goal 3, to address this complex and important task, natural and social scientists work together in collaboration with researchers from the fields of engineering related to sea routes, shipping, waste, and living environment. Specifically,

- We will build an observation network of the terrestrial environment and ecosystems in Siberia and Alaska, and assess the impact of environmental changes on energy resources and food.
- Focusing on the Northern Sea Routes, we will develop methods to analyze sea ice conditions and deliver data for ship navigation. Further, we evaluate performance of vessels and assess the impact of oil spill accidents to contribute to safer and more efficient shipping along the Northern Sea Route.
- We focus on the coastal regions, which serve as an important human habitat as well as a transport hub in the Arctic. the Greenland coast where the melting of the ice sheet and glaciers is particularly prominent, and We perform a detailed study on Greenlandic coastal areas, where the melting of the ice sheet and glaciers is particularly prominent and rapidly changing land, ocean, and atmospheric environment is affecting society.

Researchers from the fields of natural science, engineering, and social science collaborate to obtain a multifaceted understanding and assessment of how society is affected by changes in climate and the natural environment.

For a Sustainable Future in the Arctic

The distinctive feature of Strategic Goal 3 is to expand our deep understanding of changes in the natural environment to broader knowledge of their impact on society. This is an important and challenging endeavor only possible based on the research findings and collaborative base established under the GRENE-Arctic and ArCS Projects. We build a new direction of research through the participation of experts from the engineering field. Our aim is to go a step further from understanding the societal impact of environmental changes to proposing ways to mitigate and respond to this impact.

For example, providing information for shipping along the Northern Sea Route is the contribution to global economic activity and cultural exchange, including for Japan. We regard local residents, administration, and government in the study area as key stakeholders. The knowledge obtained by the project will be shared with the stakeholders to propose impact mitigation and response measures with the aim of contributing to a sustainable future for the Arctic region.
The Arctic as a Global Challenge

Recent years have seen a growing recognition that issues in the Arctic region, such as the rapid change in the natural environment due to climate change, are a global challenge, resulting in the development of a range of regimes at international forums. While some of these, such as policy coordination at the Arctic Council, are led by Arctic States, others, such as the Agreement to Prevent Unregulated High Seas Fisheries in the Central Arctic Ocean, which was concluded between Arctic coastal States and distant water fishing States, are of direct interest to Japan as a participating State.

Amidst this backdrop, Arctic research has rapidly developed into an important new field in social science research. Elucidating the unique and complex political processes and international regimes in the Arctic and studying institutional solutions to the various related issues based on collaboration with the natural sciences are particularly important tasks.

Establishing an Academic Basis for Arctic Policy

In Strategic Goal 4, we aim to establish an academic basis for social science research to support the implementation and advancement of Japan’s Arctic policy, and to construct systems that help to link the natural science knowledge obtained through Japan’s Arctic research to the implementation of adaptation measures required in the Arctic region.

Specifically, we will present a design for resilient international institutions to support the sustainable transformation of the Arctic region based on empirical research of international laws and policies, and work to deliver our research findings in a form that serves as a reference for Japanese and other stakeholders working to address Arctic-related issues.

We will also conduct research in order to gain a holistic understanding of the complex political processes in the Arctic region, and study the conflicts of interests that exist between diverse stakeholders and find ways to accommodate them, which lie at the core of international discussions and regime formation in the Arctic region.

Furthermore, we will identify the necessary legal response required to achieve sustainable utilization of the Arctic region holistically, including through research based on an economic approach, so that Japan can exercise leadership regarding the range of issues related to Arctic policy.

Problem-solving Utilizing Trans-disciplinary Expert Knowledge

The distinctive feature of Strategic Goal 4 is the adoption of a problem-solving approach that links social science research concerning the political processes and international institutions in the Arctic region to scientific knowledge regarding the changes occurring in the Arctic region and their impacts in order to contribute to the resolution of actual policy issues.

Furthermore, we hope that our research will improve and expand the quality and quantity of social science research in Japan concerning the analysis of political processes and international regimes in the Arctic region. We seek to establish an academic approach aimed at problem-solving through the utilization of trans-disciplinary expert knowledge and communicate knowledge that helps solve issues related to the sustainability of the Arctic region as the findings of Japan’s Arctic research, while contributing to the formation of a platform for Japan’s policymakers and stakeholders to develop a strategic approach to Arctic relations.
The 11 Research Programs to be conducted in ArCS II are multidisciplinary. Each program is expected to produce significant results in Arctic research through innovative technologies and advanced approaches. In addition, we will promote mutual collaboration among the research programs to further develop the research results and achieve the strategic goals and the project goal.

Atmospheric Environment and Climate Forcings in the Arctic

Principal Investigator
Makoto Koike
(The University of Tokyo)

Atmospheric species such as greenhouse gases (GHG) and aerosols in the Arctic atmosphere as well as clouds are considered to have a major influence on Arctic climate due to their impact on radiation balance. Our research aims to elucidate behaviors of these atmospheric species and clouds and the causes of their variations by utilizing advanced measurement technologies and numeric modeling. In our study of GHGs, we will use land-based stations, aircraft, and Research Vessel Mirai to conduct accurate measurements of GHG concentrations and their isotope ratios in the Arctic atmosphere, and use atmospheric transport modeling and land ecosystem modeling to estimate the GHG emission/absorption fluxes. In our study of aerosols, we will conduct network observation of Arctic black carbon (BC) aerosol, which strongly absorbs solar radiation. We will also measure various anthropogenic and natural aerosols in the Ny-Ålesund Observatory to study their behaviors and impacts on radiation. We also aim to characterize cloud microphysical properties in the Arctic and study aerosol impacts on clouds by making continuous observations. Furthermore, we will work to quantify the transportation process and impact of aerosols originating from anthropogenic sources and forest fires in Asia and Siberia that are transported to the Arctic, using our observation network and advanced modeling that enables tracking of individual particles.

Vertical column amounts of BC on September 29, 2016 estimated using numeric modeling (red: anthropogenic sources; blue: forest fires). Light blue and blue dots represent the locations of Research Vessel Mirai and ground observation stations (Poker Flat and Yakutsk), respectively. Figure: Masayuki Takigawa (JAMSTEC)

Research and Public Dataset Production on the Arctic Marine Environment

Principal Investigator
Eiji Watanabe
(JAMSTEC)

Knowledge regarding ocean heat transport, marine ecosystem, and biogeochemical cycles in the Arctic central basins and marginal ice zones is still insufficient, and studying these topics is a pressing task in order to achieve sustainable utilization of the rapidly changing polar region. In this research program, we aim to clarify the Arctic marine environment, following three sub-programs:

1) Ocean Heat/Freshwater Transport and Biogeochemical Cycles in Seasonal and Multi-Year Sea-Ice Zones.
2) Vulnerability and Resilience of Marine Ecosystem in Response to Rapid Sea-Ice Retreat
3) Air–Sea (Including Waves) Interactions Related to Sea Ice

Each of the team members participates in multiple sub-programs, and we will aim to create an overall picture of the Arctic marine environment by exchanging information with related other groups. Our efforts with advanced observation systems to approach the marginal and multi-year ice zones - which despite being important areas had thus far been difficult to access - represent a major progression from the GRENE-Arctic and ArCS projects. As one means to provide valuable findings related with human society, we will release public datasets on the Arctic marine environment.

Analysis of marine environmental DNA
Illustration: Akihide Kasai (Hokkaido University)

Sea-ice sampling at the ice camp
Photo: Daii Nomura (Hokkaido University)

The findings of sub-programs 1 and 2 will contribute to the preservation and sustainable use of fish stocks controlled by the Agreement to Prevent Unregulated High Seas Fisheries in the Central Arctic Ocean, as well as ecosystem-based management of marine food sources. Knowledge based on surveys in marginal ice zones and ice camp stations in sub-program 3 will be utilized to achieve more accurate prediction of sea conditions for safe and efficient navigation along the Arctic Sea Route.
Air temperature in the Arctic is rapidly increasing at twice the global mean due to Arctic Amplification. This would accelerate the surface melting of glaciers and ice sheet and shorten the snow cover duration, by which the ice-albedo feedback is enhanced. As a result, it is expected to cause a further sea level rise and changes in the surrounding environments and climate conditions in the Arctic. We implement the following three sub-programs to clarify these mechanisms and their impacts. In sub-program 1, we will quantify the changes in ice sheet mass balance and cryospheric environment in the Arctic and elucidate their mechanisms, by means of in-situ measurements, satellite remote sensing, and numerical modelling. We focus on the near-surface physical and chemical processes such as glacial microbes, light-absorbing aerosols, and snow grain growth, which affect the snow and ice albedos. Under sub-program 2, we will study the past warming trends and environmental change in Greenland since the Industrial Revolution. We will also investigate abrupt climate changes during the last glacial period and their links to the climate and environment in mid-low-latitudes. Our study will provide us with essential information for understanding of mechanisms and impacts of abrupt climate changes, which is prerequisite to prepare for future global warming and its socio-economic impacts. In sub-program 3, we will clarify processes of chemical reactions and cloud formation caused by local water circulation in seasonal sea ice areas and releases of aerosols and water vapor from sea ice areas through conducting meteorological monitoring and ice core analyses in the northwestern Greenland. Also, we aim to provide a quantitative database of the relevant processes to atmospheric models.
The Arctic environment is changing rapidly as climate warming progresses, affecting regions outside the Arctic in a variety of ways. There is a growing need for precise weather and climate prediction in order to develop adaptation measures both within and outside the Arctic region, as well as to utilize and develop the Arctic region. In order to respond to this need, this research program will focus on the following four objectives.

1. We will focus on several climate processes unique to the Arctic region, and work to refine our climate models by contrasting them with the latest observation knowledge and utilizing Large-Eddy Simulations (LES) and high-resolution regional modeling.

2. We will work to refine climate prediction by constructing new data sets regarding climate variables in the Arctic region and developing data assimilation methods to enable these data sets to be utilized in the initialization of climate models.

3. We will investigate the possibility of drastic long-term changes in the cryosphere and by extension the Arctic environment by utilizing regional climate modeling and other means to express snow and ice-related processes in greater detail.

4. We will work to improve prediction precision of waves and sea ice distribution in marginal ice zones and coastal regions in order to ensure safe and efficient utilization of Arctic sea routes and protect the living environment of indigenous residents of Arctic coastal regions.

During research implementation, we will establish the sub-program Arctic Climate Process Modeling toward Objective 1, the sub-program Improvement of Climate Prediction toward Objectives 2 and 3, and the sub-program Towards a Coupled Wave-Ice Prediction toward Objective 4.

As changes in the Arctic environment influence energy resources, fisheries, and agricultural production, this shift impacts the food security of human societies in the Arctic region, including indigenous communities, as well as food consumption in societies outside the Arctic region. In this research, we will work to evaluate the impact that global warming has on the Arctic region at a regional ecosystem level including soil and ecosystems, as well as to elucidate the effects from the perspective of human energy and food resources. Our research will focus on the investigation of three areas: evaluation of the degree of degradation of perennial and ecosystems, evaluation of the economic and social effects of energy resource development, and the social and cultural impact of changes in biological production on human life, primarily focusing on indigenous societies.

We will pay particular attention to the exchange between Arctic and non-Arctic societies, particularly that of East Asian nations including Japan, to analyze the impact of the Arctic region on East Asia, while also analyzing the influence that political and economic developments in East Asia have on environmental conservation in the Arctic region. We will also aim to elucidate knowledge toward the realization of human security in the Arctic region, including freedom from threats, freedom from want, and freedom to live with dignity. We will communicate related findings to stakeholders such as Arctic communities and local governments through media including workshops, exhibitions, and publications. In proceeding with this study, we will work to collaborate with not only Russian researchers, research institutions, communities and local governments, but also with researchers and institutions from other nations with track records in Arctic research, including Finland, Germany, the U.K., and the U.S., as well as researchers from China and South Korea for studying the region’s relations with East Asia.

Considering the environmental changes taking place in the Arctic Ocean, the use of Arctic sea routes (Northern Sea Route and Northwest Passage) is expected to increase, and the passage of ships with low ice classes and large vessels is predicted to rise. Meanwhile, it has been suggested that waves will be likely to penetrate deeper into drift ice fields, disrupting passage, and that hard ice pieces from multi-year ice and glaciers may drift into sea routes. In order to conserve the Arctic Ocean environment and ensure sustainable use of the sea routes in these circumstances, the provision of sea route ice information in order to support safe passage, science-based rather than experience-based evaluation of vessel performance and safety, and accident response will become more critical than ever.

In addition, methods to enable the economic selection of passages and operating vessels are required, with safety soundly assured.

In this Research Program, we will aim to construct methods to support shipping operations in the near future in light of environmental changes in the Arctic Ocean. Specifically, in addition to the ice condition information we currently provide, we will establish the following three sub-programs: 1. development of methods to generate sea ice information to support ship navigation, including information on sea ice thickness and deformed ice, 2. performance (speed and fuel consumption) and safety evaluation of a ship based on scientific methods, and 3. impact assessment of and countermeasures for oil spill accidents, which are a particular environmental risk. We will also focus on the economic aspects when the above are taken into account and evaluate the economy of Arctic Sea Routes in the near future, as well as the ripple effect on society.
The focus of this Research Program is the Arctic coastal regions, which are undergoing rapid changes under the influence of climate change. To contribute to sustainable future of residents in the Arctic coast, we evaluate the societal impact of climate change and study measures of mitigation. Our primarily study site is the Qaanaaq region in northwestern Greenland. Based on the relationship established with local residents through the GRENE and ArCS Projects, study results are utilized for social implementation through dialog with local residents, government, and private sectors.

In Subproject "Ocean Environment and Marine Ecosystem" investigates the impact of changes in marine environment and ecosystems on fishing and hunting, important economic and cultural activities in the Arctic region. In Subproject "Glaciers and Ice Sheet", we quantify melting and mass loss of glaciers and ice sheet, which affects the Greenlandic and worldwide society through changes in ocean environment, floods of glacial streams, and rising sea levels. In Subproject "Land, Atmosphere and Sea Ice" we study landslides and thawing permafrost, which frequently cause disasters in coastal regions. We also develop a sustainable and precise atmospheric observation system with drones to improve weather forecast. Subproject "Engineering Approach" evaluates the environmental impact of waste disposal and living environments in the Arctic region. In "Humanities and Social Sciences", we investigate the influence of climate change on society to contribute to the wellbeing of Arctic residents in collaboration with other research programs. By sharing findings, we work together with local residents, government, and private sectors to find solutions for Greenlandic society. The goal of the project is to contribute to a sustainable future in the Arctic region.

Providing stability and predictability in the society is the purpose of legal regimes. For Japan, as a non-Arctic nation, the international legal regimes form the basis when seeking social stability in the Arctic region. This Research Program aims to show how the international legal regimes can adapt to the rapid natural environmental and socioeconomic changes and geopolitical tensions in the Arctic, and to provide stability and predictability to all stakeholders planning access to the Arctic. Maintaining and strengthening the rule of law in the Arctic region is a pillar of Japan’s Arctic policy.

This research aims to create a blueprint for resilient international regimes to support the sustainability of the transforming Arctic region, based on evidence-based research on international law and policy related to the Arctic. To achieve this objective, we will firstly conduct research in order to construct and enhance international regimes that contribute to the promotion of international scientific cooperation in the Arctic, such as the Arctic Council and the Agreement on Enhancing International Arctic Scientific Cooperation. Secondly, we will study international law that promotes the sustainable use of the Arctic Ocean, including international law governing the Northern Sea Route and the Agreement to Prevent Unregulated High Seas Fisheries in the Central Arctic Ocean. Thirdly, we will pursue integrated research on the rights of Indigenous Peoples and related international law for the sustainable development of the Arctic region, and mobilize knowledge of international human rights law, international environmental law, and international economic/investment law for that purpose.

The above direction of this research will be reviewed and implemented, we aim to help a greater number of stakeholders such as state authorities, local authorities, non-profit organizations, indigenous groups and scientists.

In order to further accelerate initiatives started under the ArCS program, this Research Program aims to introduce a follow-up system for discussions at the Arctic Council, as well as build a transdisciplinary taskforce to lead the implementation of adaptation measures in the Arctic. To this end, we are establishing a sub-research program on political studies. Firstly, this program will contribute to improved accuracy of scientific knowledge delivery by conducting research to holistically elucidate the diverse interests at play, which are rooted in values such as indigenous and traditional knowledge, as well as the complex political processes in the Arctic, which are formed through confrontation and coordination between diverse actors/stakeholders such as state authorities, local authorities, non-profit organizations, indigenous groups and scientists.

Secondly, we will work to clarify Japan’s interests and position and establish it as a more internationally trusted presence by clarifying the discourse on the motivations behind Japan’s involvement in the Arctic, the underlying values it holds that drive this involvement, the benefits of involving Japan, and the historical interests of the Japanese people, thereby deepening understanding of the formation and evolution of national awareness and identity regarding the Arctic.

Third, we will conduct compelling economics-based policy research in order to contribute to Japan’s leadership on key strategic policy issues such as black carbon, ecosystem services assessment, ocean plastics, and clean energy.

Through this political research and its social implementation, we aim to help a greater number of Japanese stakeholders deliver more effective solutions to challenges faced in the Arctic region.

11 Research Programs
2 Priority Subjects

Priority Subject 1  Capacity Building and Research Promotion

The capacity building of early career researchers who will play a key role in future Arctic research projects and resolving a range of Arctic-related issues is an urgent challenge in Japan’s Arctic policy, centered on research and development, international cooperation, and sustainable use. In this Priority Subject 1, we aim to develop capacity building for early career researchers by sending them to overseas Arctic research institutes, in order to gain experiences in overseas exchanges, including collaborative observations and international discussions. Through the systematic and continuous such efforts, we aim to strengthen the research capabilities of the research organizations involved. This subject will also contribute to the project’s goal by soliciting proposals on urgent and/or challenging research topics that complement the Strategic Goals, in light of dynamically developing international trends in Arctic research.

- International Research Exchange Program

We will promote multi-year systematic exchanges of researchers, not on an individual basis, but between laboratories/research groups at universities and other research institutions in Japan and those in major overseas Arctic research institutes. This will contribute to building sustainable international research collaboration and an international network of researchers, which will, even after the program is completed, strengthen the capabilities of the whole Arctic research community as well as develop stable career paths for early career researchers.

- Overseas Fellowship Program

In addition to providing opportunities for early career researchers and graduate students to pursue their research projects abroad, we will also support presentation and information gathering at international conferences by staff members in industrial and governmental sectors during their stay at overseas institutions. The goal of the program is to support voluntary and autonomous young applicants to build their capacities overseas who are eligible to play key roles in international arenas for the Arctic issues.

- Call for Complementary Research Projects

Based on the latest international trends/needs in Arctic research, we will call for spontaneous research proposals from early career researchers and urgent global-scale proposals that have not been included in our Research Programs, to complement and achieve the Strategic Goals.
We will promote two Priority Subjects in ArCS II: Capacity Building and Research Promotion, first of all, and Strategic Dissemination of Arctic Information. For Priority Subject 1, we will step up capacity building of early career researchers and research capabilities of the whole Arctic research community. For Priority Subject 2, we will disseminate the academic knowledge obtained through this project to society and stakeholders in a timely and easy-to-understand manner through a newly built web platform for providing information that contributes to social implementations.

### Priority Subject 2 Strategic Dissemination of Arctic Information

The Subject 2 is to provide domestic and international stakeholders with the latest scientific knowledge and research findings, such as the present and future projection of the Arctic environment, its social impact, and legal policy responses to assist in the establishment of international regulations, that were obtained through Research Programs conducted under the four Strategic Goals. This will finally contribute to the Project's Goal by providing an information infrastructure to support social implementation trials. To achieve this objective, we will pursue the following four initiatives:

#### - Arctic Environmental Information Website

We will develop and operate a portal site that will work for Japan's comprehensive information platform on the Arctic issues. This website will collect and disseminate information on the progress and research findings from the ArCS II project, the latest findings and news on the Arctic from all over the world, as well as provide the latest information on Arctic-related legal policy and economic trends to a variety of stakeholders from an integrated, comprehensive perspective.

#### - Arctic Sea Ice Information Center

Arctic Sea Ice Information Center will further improve the dissemination of mid-term Arctic sea ice forecast produced under the ArCS project. To provide mid-term and short-term Arctic sea ice forecast, short-term wave forecast (Strategic Goal 2), and hazard mapping of oil spill in ice-covered sea and navigation simulation (Strategic Goal 3), we will operate the Center as an information hub for stakeholders in close collaboration with the Strategic Goals and Research Programs.

We will prepare and disseminate forecast information critical for the use of Arctic sea routes to stakeholders, review its effectiveness, and provide feedbacks to researchers in order to develop a quick and efficient method for social implementation.

#### - Dispatch of Experts and Provision of Information to/Dialog with Policymakers

We will send experts to the Arctic Council (AC) and other specialist meetings and working groups to gather and disseminate the latest information related to the Arctic region. The researchers of International Politics and Policy Dialogue Working Group will analyze information in order to regularly deliver feedback to policy makers. By providing timely information and advice from this project as a think-tank for the Arctic issues, we will eventually contribute to the formulation of Japan's Arctic policy.

#### - Promotion of Education and Outreach

In order to communicate the latest knowledge and information on the Arctic climate and environmental changes to adults and the younger generation, we will promote diverse education and outreach activities to make more people get interested in global environmental issues including the Arctic.
The observation facilities operated and maintained by NIPR and JAMSTEC in collaboration with research institutes in the Arctic are to be allocated as International Collaboration Sites. In addition to international collaboration through international joint research, the facilities are to be utilized for capacity building of early career researchers.
Archiving and analyzing data from survey observations in the Arctic is essential for Arctic research. The facilities maintained and operated by NIPR, JAMSTEC, Hokkaido University, and the Japan Aerospace Exploration Agency (JAXA) are used as ArCS II research infrastructures to support research in the Arctic region. These research infrastructures will also contribute to human resource development, outreach, and information dissemination.

Research Vessel

The Mirai, an oceanographic research vessel owned by JAMSTEC, is a maritime research platform with advanced observation equipment, onboard and inboard facilities, and navigation capabilities. During the project period, the Mirai will conduct observation voyages in the Arctic Ocean to investigate changes in the marine environment and marine ecosystem. We also plan to provide Hokkaido University's training vessel, “Oshoro Maru”, to promote its use as a platform for education and outreach activities.

Earth Observation Satellite Data

Taking advantage of satellite observations covering a wide range of the Arctic region in space and time, we will provide remote-sensing data on oceans, land, ecosystems, and cryosphere from JAXA’s earth observation satellites in an easy-to-access format for researchers in conjunction with the Arctic Data archive System (ADS).

Arctic Data archive System

Through archiving and publishing research data acquired in the Arctic region, we will promote the development of an “Open Science” and “Big Data” infrastructure for domestic and international Arctic research. ADS is developing proprietary technologies such as VENUS, a system to support ship navigation, and VISION, a data visualization tool, which will contribute to the social implementation of research results and to education and outreach activities using data.

Mirai navigation support by VENUS at ADS (Figure shows sea ice forecast for 10 days after October 15, 2020)

Accurate projections of weather and sea ice conditions are essential for safe navigation in sea ice regions. To support the Mirai's Arctic voyage, meteorological data around the vessel, sea ice data from the Earth observation satellite Shizuku, weather forecast data from the European Medium-term Prediction Center, and sea ice forecast data modeled and calculated by the group at University of Tokyo are used. These data are transmitted from ADS to VENUS aboard the Mirai to contribute to safe sea voyages.
**ArCS II Project Structure**

**Project Goal**

“Towards the realization of a sustainable society, we promote advanced research to understand the current status and process of environmental changes in the Arctic and to improve meteorological and climate prediction in order to assess the impact of rapid environmental changes in the Arctic on human society, including Japan, as well as to implement the results of this research into society. We also provide domestic and international stakeholders with our scientific knowledge that will be a basis for legal and policy for the formation of international rules in the Arctic.”

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**4 Strategic Goals**

1. Advanced Observation of Arctic Environmental Change
2. Improvement of Weather and Climate Prediction
3. Impact of Arctic Environmental Change on Society
4. Legal/Policy Response and Research Implementation for a Sustainable Arctic

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**2 Priority Subjects**

1. Capacity Building and Research Promotion
2. Strategic Dissemination of Arctic Information

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**11 Research Programs**

<table>
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<tr>
<th>Strategic Goal</th>
<th>Priority Subject</th>
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<tr>
<td>Advanced Observation of Arctic Environmental Change</td>
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</tbody>
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**Research Infrastructures**

- International Collaboration Site
- Research Vessel
- Earth Observation Satellite Data
- Arctic Data archive System

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**Management**

- **Steering Committee**
  - Project Director, Sub-Project Director, Experts in other institutes
  - Self-checking, evaluation, advising and approval for the adequacy of the plans, the systems and the methods

- **Project Headquarters**
  - Project Director, Sub-Project Director, Research Director
  - Management and collaboration of the project

- **International Advisory Board**
  - Experts in foreign institutes
  - Advice on the project

- **Secretariat**
  - Representative Institute, Deputy Representative Institute
  - Planning and operation, Research activity support

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**Editor**

Secretariat of Arctic Challenge for Sustainability II (ArCS II) Project

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