IACE

Institute of Arctic Climate and Environment Research

JAMSTEC

For the future of the Arctic, for the future of the Earth.

As global warming clearly progresses and its effects on human society become increasingly threatening, the Arctic region has been recognized as one of the most rapidly changing areas in the world. Researchers have demonstrated that the Arctic is warming approximately three times faster than the global average; this means that sea ice, permafrost, and ice sheets are melting dramatically. Accelerated environmental change, therefore, means that terrestrial and marine ecosystems are changing, which directly affects those who depend on its resources. Populations in the Arctic region are facing ceaseless hardships and are being forced to adapt to the rapidly changing environment.

Unfortunately, the effects of climate change are not constrained to the Arctic region, and its rapid warming is triggering threats globally: sea-level rise and weather pattern shifts are just two examples of current adversity, while there are still more unknown threats from climate change being discovered. Researchers are therefore required to investigate such rapid environmental changes, to then understand the current global impacts, and better predict the future state of the planet.

Our institute (IACE) is conducting research and development to understand the current state of the Arctic region by identifying the causes of change and indicating their impact on the future environment. For instance, when it comes to future predictions regarding the Arctic and global environmental changes, there are still many uncertainties; therefore, by collecting accurate and comprehensive data, especially in the sea ice and permafrost regions, we will be able to reduce these uncertainties. Such data and new knowledge can correct any misunderstandings of important processes and will support the development of more accurate models for future predictions. Based on our results, we have and will continue to provide useful data regarding Arctic changes to not only the scientific community but also to stakeholders in the Arctic and global issues.

Takashi Kikuchi
Director, Institute of Arctic Climate and Environment Research (IACE)

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Finding the Current Status and Trend

Our major goals are to detect the status and trend of the ongoing rapid changes in the Arctic marine environment and to further assess those impacts on the global climate system. We are collecting seawater/sediment samples, through the Research Vessel (R/V) *Mirai* Arctic Ocean expeditions, drifting-buoy measurement of 'under-ice' conditions, and numerical experiments with regional models to clarify various atmosphere–sea ice–ocean–land interactions.

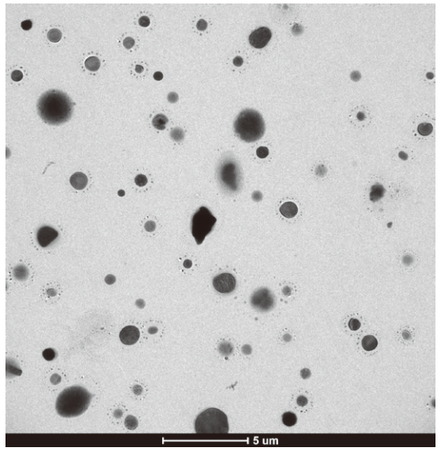
Ice-tethered buoy deployed in the Beaufort Sea

R/V *Mirai* sailing along the marginal sea-ice area

Connecting the dots

Arctic climate might be affected by the pollutants transported from the megacities in mid-latitudes. Boreal forests are also crucial for the global carbon exchange.

By connecting “in situ” observations at the source regions and the receptor regions, with observations and model simulations, the types of questions we would like to answer are: “What is happening in the world?” and, “How the constituents are being transported,” and, “How the constituents affect climate and weather.”



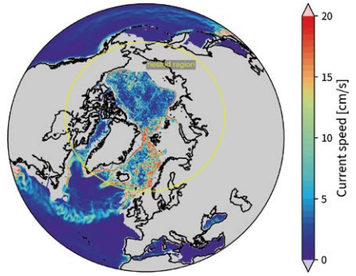
Electron micrograph of aerosol particles collected by air sampler during the Arctic cruise

Observational instruments on the deck of R/V *Mirai*

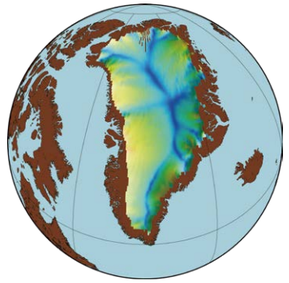
Projecting the future of the "Pan-Arctic" climate

The Arctic is the region where the impacts of climate change are most pronounced. More recently, it has become clear that changes occurring in the Arctic can affect the climate of other regions of the Earth. To understand these rapid and interactive processes and improve the reliability of future climate projections, our group is developing advanced models and elucidating various phenomena using these models.

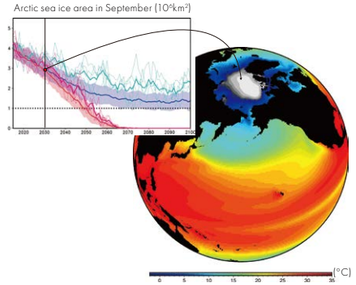
Pan-Arctic Climate Change Projection Research Group



Simulated oceanic current speed at 400 m depth in an Arctic Ocean high-resolution modeling



Simulated high resolution surface velocity and topography of Greenland ice sheet



Sea ice and sea surface temperature in 2030 from the MIROC6 SSP5-8.5 scenario projection

Covering the knowledge gap in the Arctic Ocean

There are many knowledge gaps concerning the sea ice of the Arctic Ocean; sea ice thickness, dynamics, ecosystem, and ice-ocean interaction. JAMSTEC is currently developing drones that can operate autonomously on and under sea ice for observation. The under-ice drone will have the capability to measure water temperature, salinity, and other ocean parameters directly under the sea ice. It will also capture images of the shape of the sea ice and observe the presence of living organisms below. The under-ice drone will also be able to communicate with an aerial drone and/or a remote-controlled snow robot (to be developed in the near future). This technology is to secure safe observation and navigation of sea ice by the transmission of signals between those two drones. Since the area under the sea ice remains difficult to observe, JAMSTEC aims to enrich existing knowledge by successfully developing this new infrastructure.

Test of measurement sensor suit using electromagnetic waves for data transmission between under-ice and in-air at lake Saroma (frozen lake)

COMAI (Challenge of Observation and Measurement under Arctic Ice) sea trial in the Arctic Ocean

Network for National and International Cooperation and Collaboration

The Arctic comprises the Arctic Ocean and surrounding Arctic Circle countries. To understand the rapid environmental changes in the Arctic, their impacts, and possible future changes, international research cooperation and collaboration, including Arctic Circle countries, is essential. Under these circumstances, Japan was admitted to the Arctic Council as an observer in 2013. By pursuing domestic and international cooperative and collaborative research and making advantageous use of their respective characteristics in that research, IACE is conducting research that will lead to solutions for environmental issues in the Arctic and globally.

Domestic Collaboration

Collaborative Institutes in Japan

National Institute of Polar Research (NIPR)
Hokkaido University
The University of Tokyo
Japan Aerospace Exploration Agency (JAXA)
Kobe University
Nagoya University
National Institute for Environmental Studies (NIES)
Tokyo University of Marine Science and Technology
University of Toyama

Research Projects in Japan

Arctic Challenge for Sustainability II (ArCS II)

International Collaboration

International Collaborative Institutes

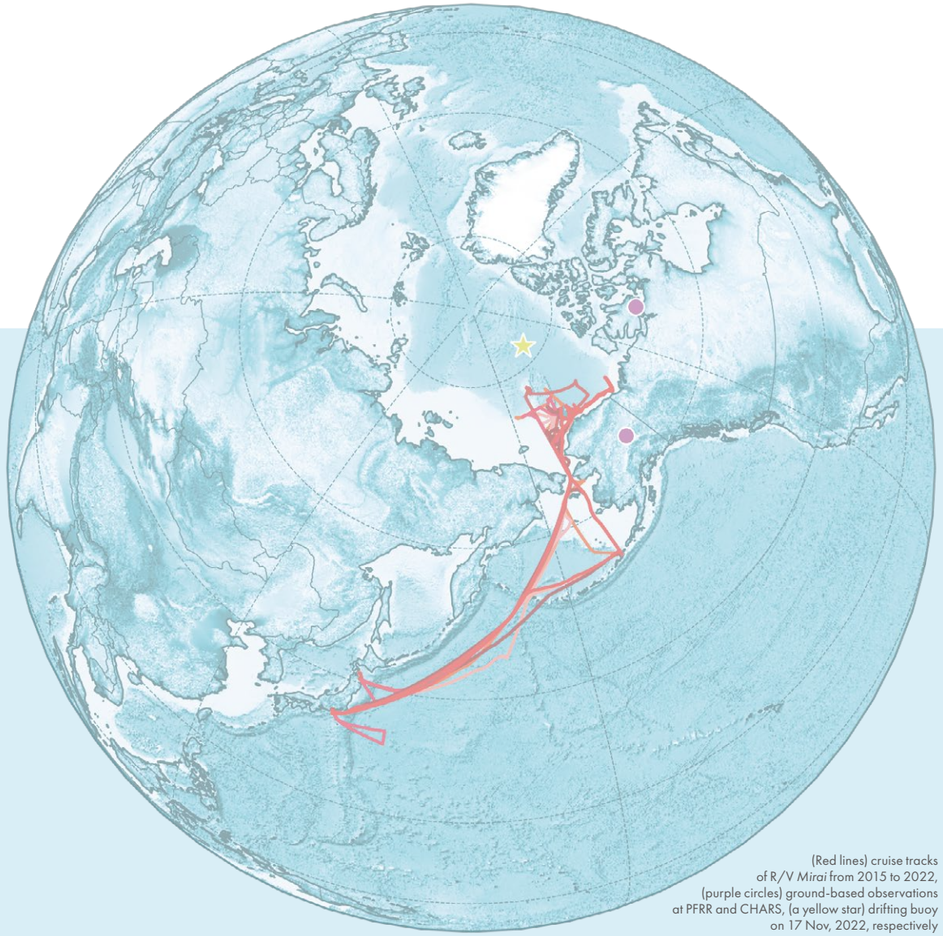
Alfred Wegener Institute (AWI)
Institute for Marine Research, Norway (IMR)
Institute of Ocean Sciences, Canada (IOS)
International Arctic Research Center (IARC)
Korea Polar Research Institute (KOPRI)
National Centre for Polar and Ocean Research (NCPOR)
National Oceanic and Atmospheric Administration (NOAA)
Norwegian Polar Institute (NPI)
University of Tromsø
University of Washington (UW)
Woods Hole Oceanographic Institution (WHOI)

International Research Projects

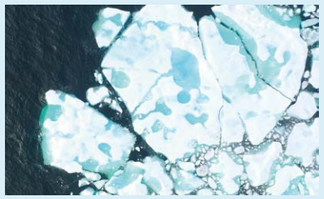
Arctic PASSION
Arctic-Subarctic Ocean Fluxes (ASOF)
Association of Polar Early Career Scientists (APECS)
Coupled Model Intercomparison Project (CMIP)
Distributed Biological Observatory (DBO)
Ecosystem Studies of Subarctic and Arctic Seas (ESSAS)
Intergovernmental Panel on Climate Change (IPCC)
International Arctic Buoy Programme (IABP)
International Arctic Science Committee (IASC)
International Arctic Systems for Observing the Atmosphere (IASOA)
Air Pollution in the Arctic: Climate, Environment and Societies (PACES)
Pacific Arctic Group (PAG)
Polar Climate Predictability Initiative (PCPI)
World Climate Research Programme (WCRP)

Other collaborative activities

Ameriflux
Fluxnet



(Red lines) cruise tracks of R/V *Mirai* from 2015 to 2022, (purple circles) ground-based observations at PFRR and CHARS, (a yellow star) drifting buoy on 17 Nov, 2022, respectively



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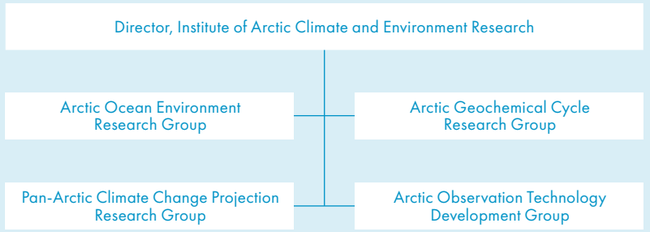

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