Synoptic Arctic Survey

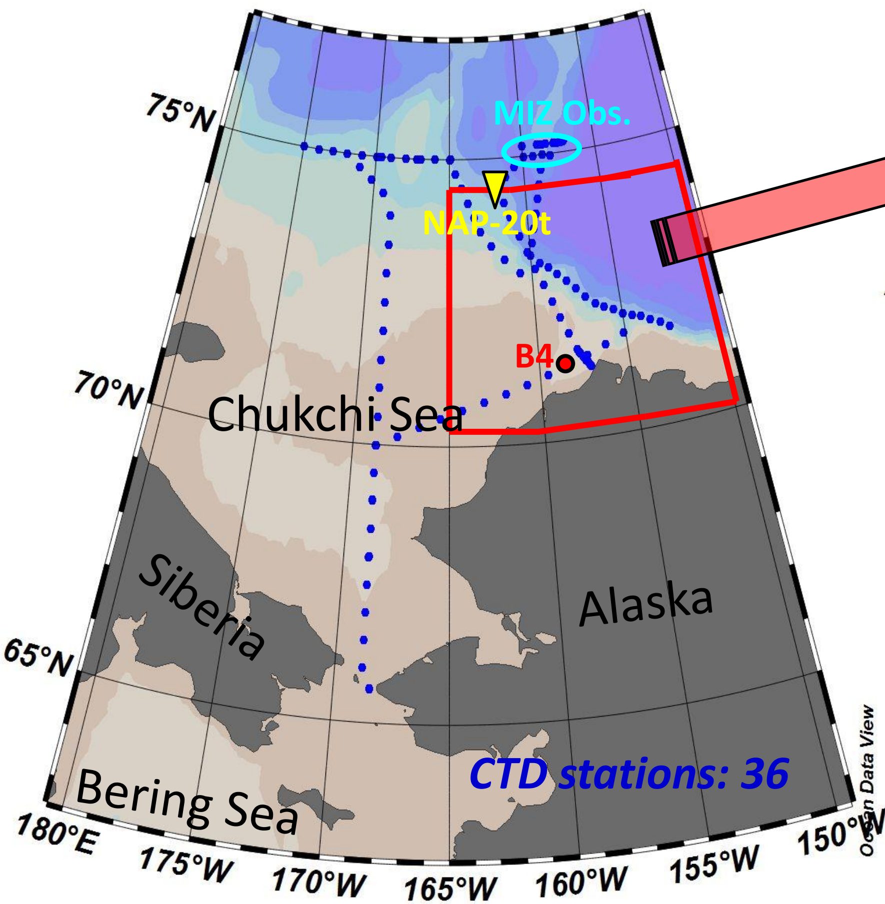
International SAS Synthesis Workshop
7–9 June 2023
Woods Hole Oceanographic Institution
Woods Hole, Massachusetts, USA

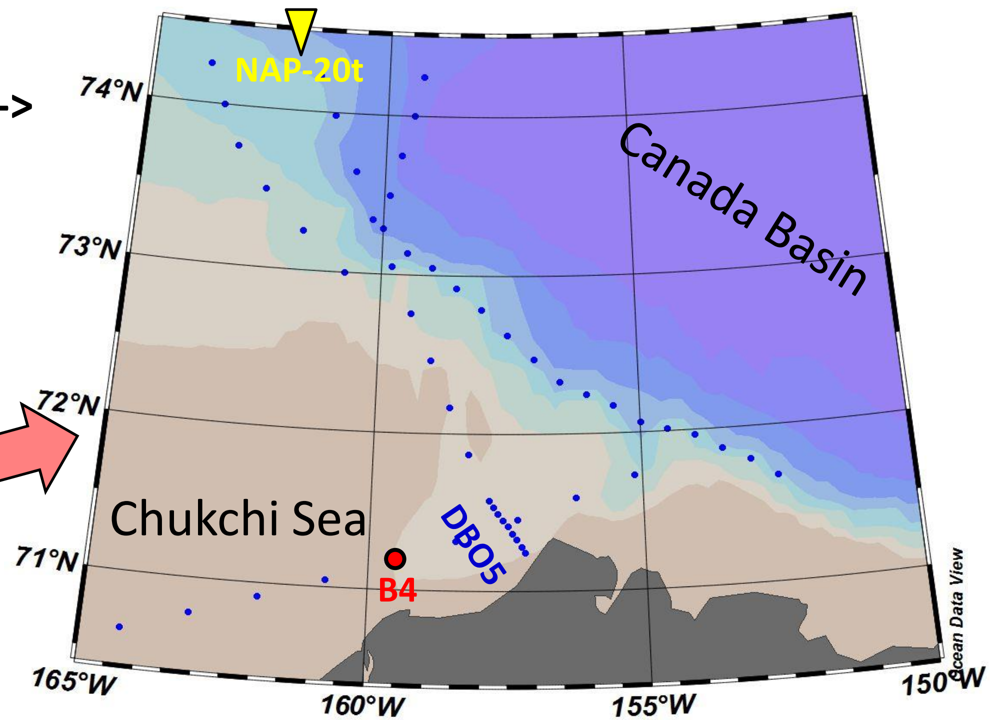
SAS-*Mirai* 2020–2022 cruises in the western Arctic Ocean (Cruises Review by Chief Scientists)

2020 Chief Scientist: Shigeto Nishino (JAMSTEC)
2021 Chief Scientist: Amane Fujiwara (JAMSTEC)
2022 Chief Scientist: Motoyo Itoh (JAMSTEC)

Map and stations of the R/V Mirai cruise in 2020

19 Sep: Shimizu, Japan -> Quarantine near the coast of Japan (14 days) ->
6 Oct: Bering St. -> Arctic Ocean (16 days) ->
21 Oct: Bering St. -> 2 Nov: Shimizu, Japan



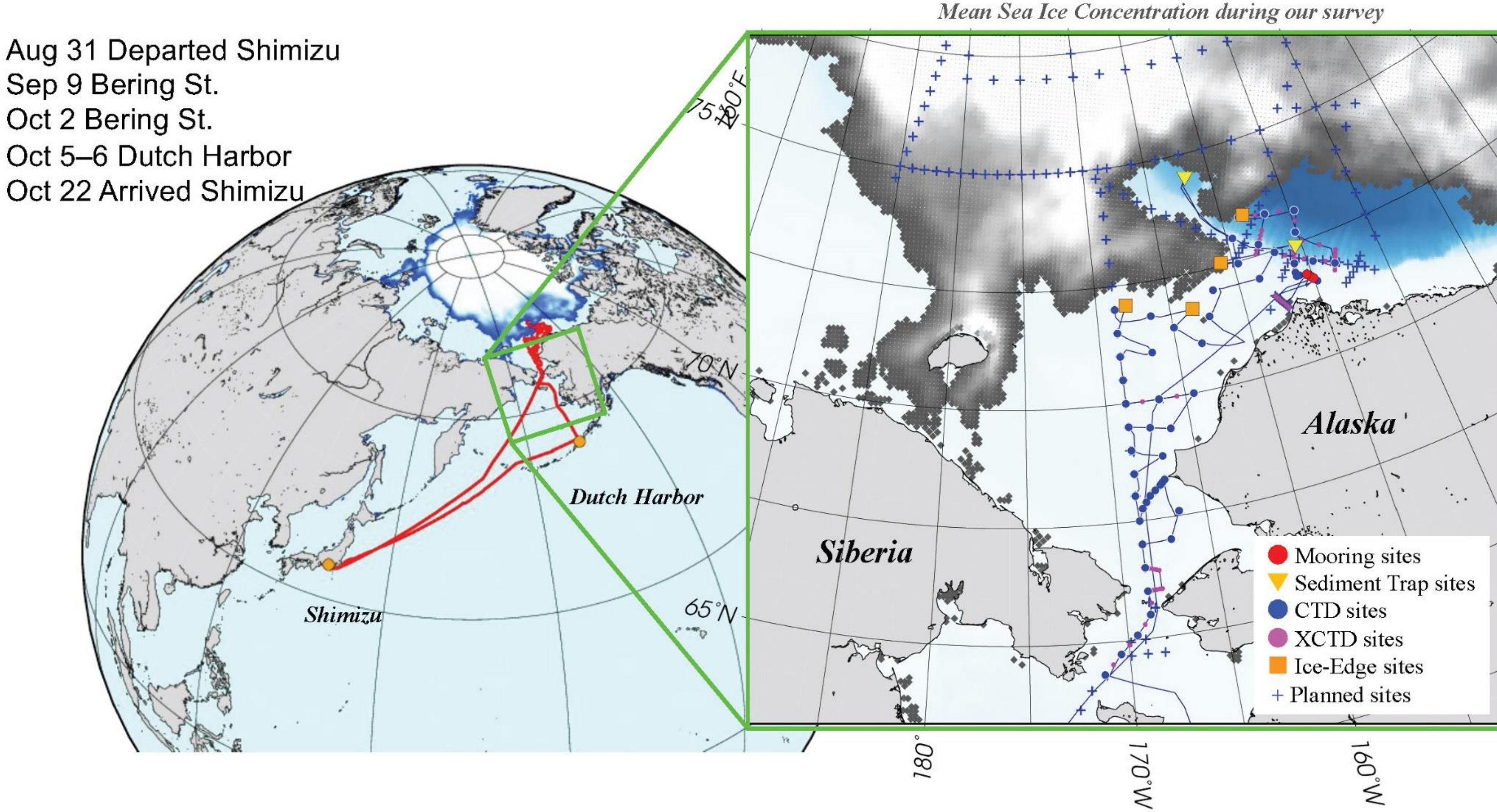


Activities

- **: CTD/XCTD, TurboMAP, Plankton net, S&M grab, Bio-optics observation**
- **: Mooring**
- **: Sediment trap**
- **: Marginal Ice Zone observation**

DBO: Distributed Biological Observatory

Map and stations of the R/V Mirai cruise in 2021

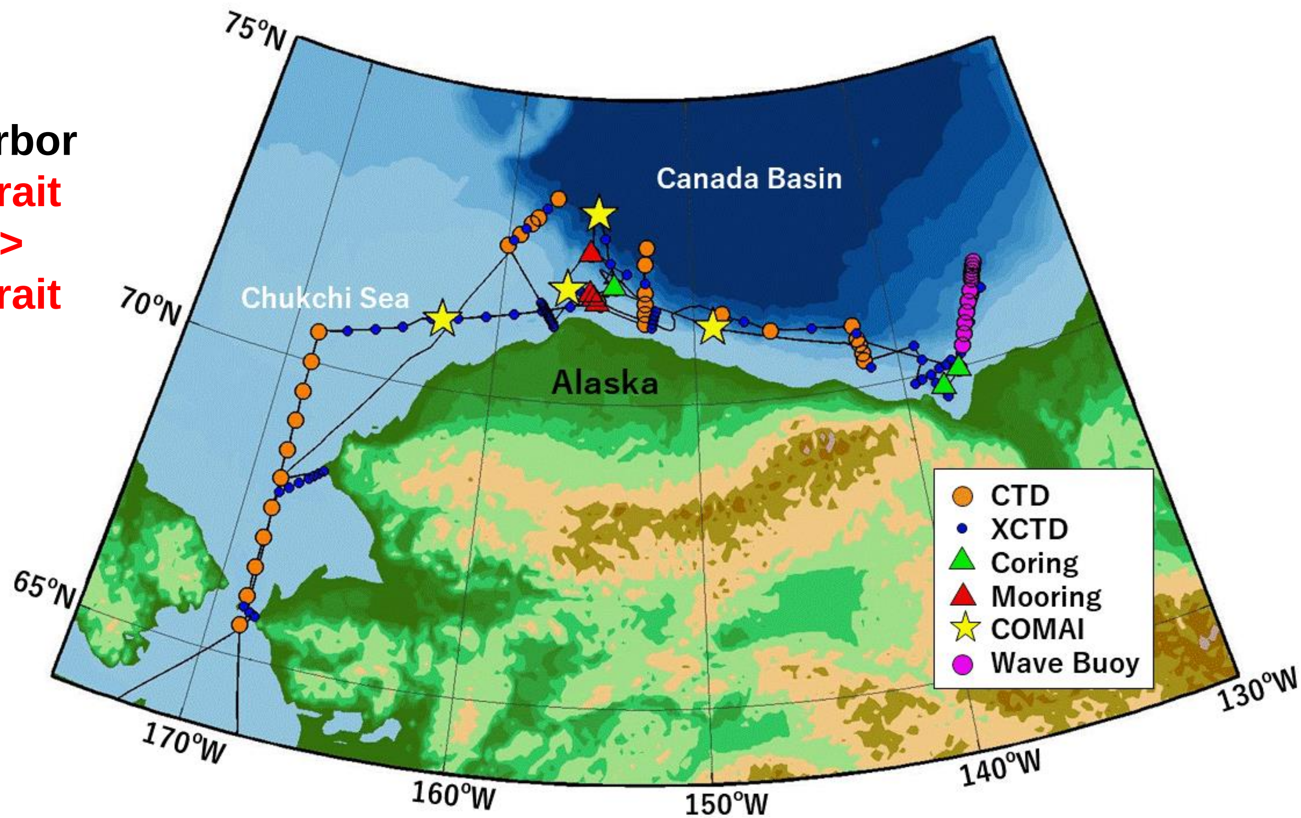


Map and stations of the R/V Mirai cruise in 2022

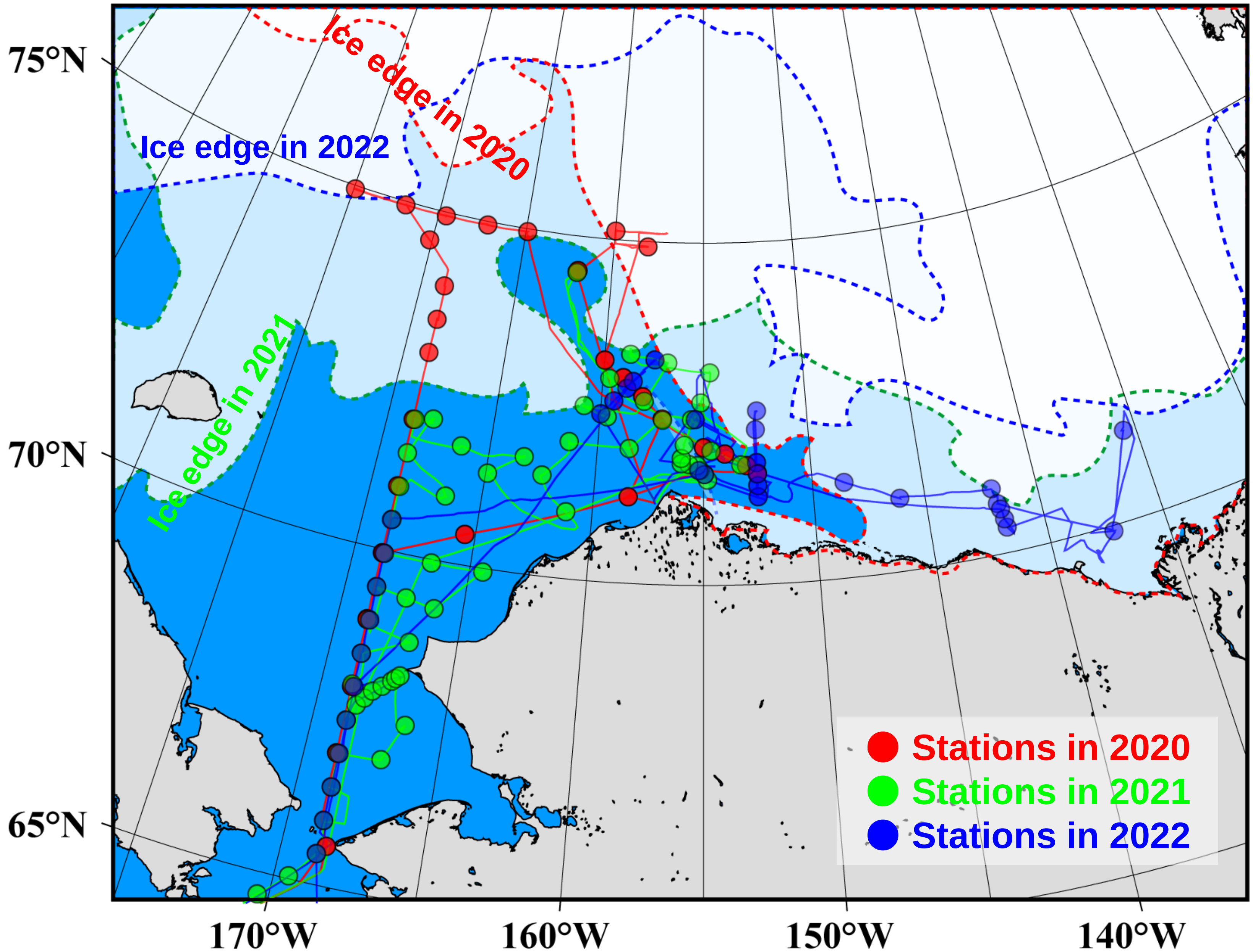
- 34stations CTD/R (Conductivity, Temperature, and Depth/Rosette Samper)
  (19 Neuston net, 17 NORPAC net, 10 clean seawater sampling and 9 Asyura sampling stations)
- 81stations XCTD (eXpendable CTD)
- 4 stations COMAI test dive
- 4 stations Sediment coring (MT1, MT2, BC2, BC2-2)
- 4 moorings Recovery and deployment at BCE, BCC, BCW, NBC.
- 15 wave buoy deployments and ice-edge observation

Underway Acoustic Doppler Current Profiler, Thermosalinograph, Meteorological Observations

8/12 Shimizu
8/21 Dutch Harbor
8/24 Bering Strait
<25 days>
9/17 Bering Strait
9/29 Shimizu

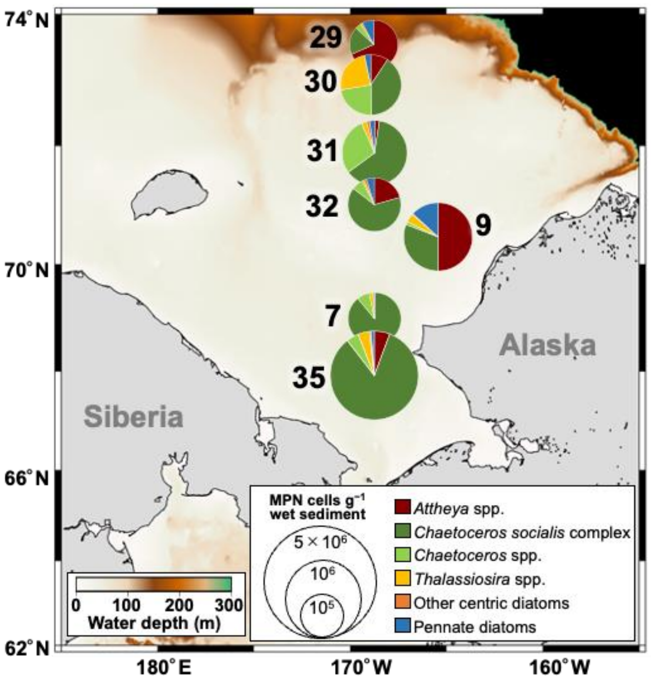


Sea-ice and stations of the R/V Mirai cruises in 2020–2022



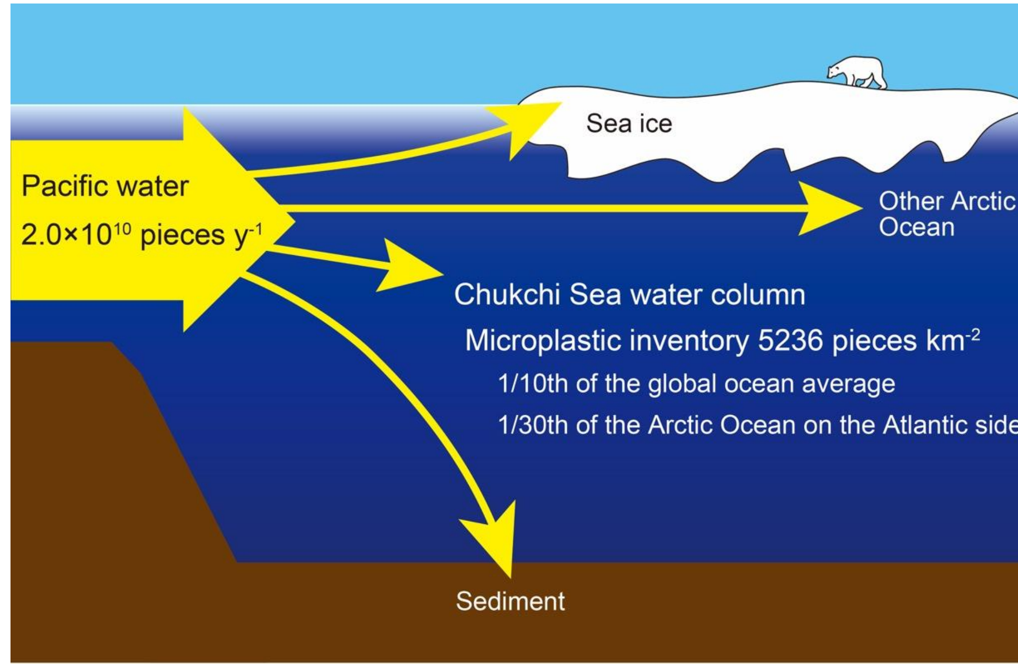
Already published SAS-related papers

Seeding potential of sediment diatom cells



[Fukai et al., 2022]

Spread of microplastic pollution in the Chukchi Sea



[Ikenoue et al., 2022]

Fukai et al. (2022), Photophysiological response of diatoms in surface sediments to light exposure: A laboratory experiment on a diatom community in sediments from the Chukchi Sea, Front. Mar. Sci., 9:998711. https://doi.org/10.3389/fmars.2022.998711

Kumamoto et al. (2022), Fukushima-derived radiocesium in the western subarctic area of the North Pacific Ocean, Bering Sea, and Arctic Ocean in 2019 and 2020, J. Environ. Radioact., 251–252, 106949. https://doi.org/10.1016/j.jenvrad.2022.106949

Ikenoue et al. (2023), Horizontal distribution of surface microplastic concentrations and water-column microplastic inventories in the Chukchi Sea, western Arctic Ocean, Science of the Total Environment, 855, 159564. https://doi.org/10.1016/j.scitotenv.2022.159564

Papers for the SAS special issue

1. **Matsuno et al.**, Sea ice melt timing and ammonium concentration can alter autumn phytoplankton composition in the Pacific Arctic.
2. **Onodera et al.**, Decadal condition changes in material transportation in the southwestern Canada Basin, 2020-2021.
3. **Fujiwara et al.**, Annual changes in phytoplankton community structure in the Barrow Canyon.
4. **Kawakami et al.**, Latitudinal transition in pelagic fish community across the Northwestern Pacific to the Arctic Chukchi sea revealed by environmental DNA metabarcoding.
5. **Nishino et al.**, Pentadal changes of hydrographic structures in the Chukchi shelf slope between 2000 and 2022.
6. **Kameyama et al.**, Dynamics of dissolved methane and its biogeochemical controlling factors in the Chukchi Sea.

Papers for other journals

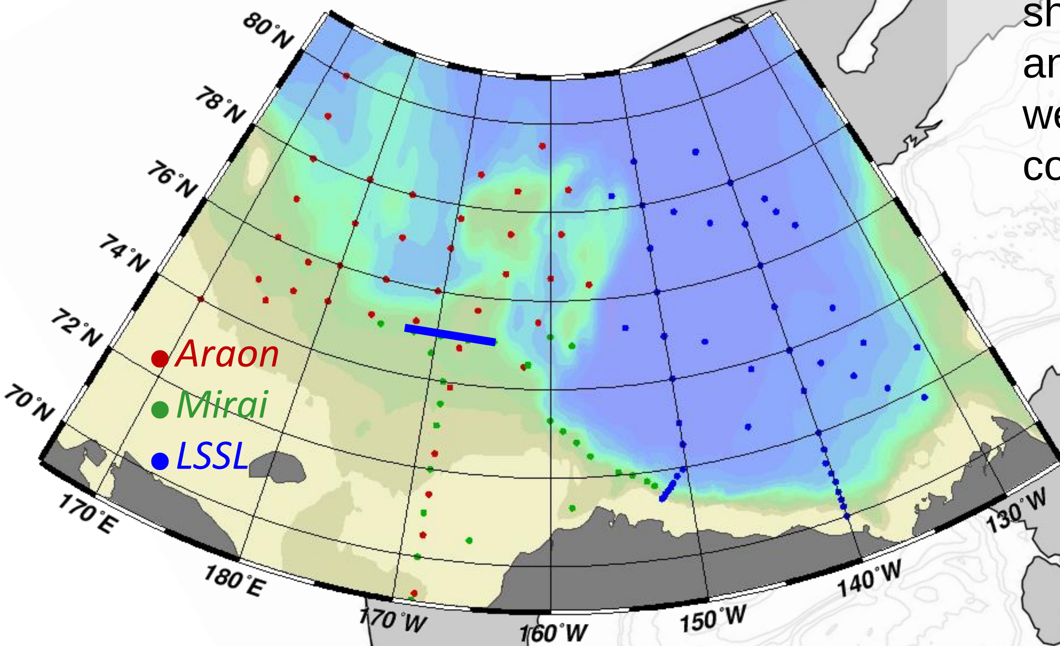
1**. Nakajima et al.,** Distribution and abundance of microplastics in near-surface waters from the Arctic Ocean to the Southern Ocean.
2. **Ikenoue et al.**, Horizontal distribution of water-column microplastic inventories in the Beaufort Sea, Arctic Ocean (To be submitted to Environmental Pollution).
3. **Murata et al.**, Decadal-scale changes of the CO_2 system in surface seawater in the western Arctic Ocean: Results from R/V Mirai's observations.
4. **Fukai et al.**, Characteristics of autumn diatom communities in the Chukchi Sea unraveled by combined DNA metabarcoding and scanning electron microscope techniques.
5**. Fujiwara et al.**, High-resolution mapping of surface phytoplankton community composition in the Chukchi Sea (To be submitted to Polar Science).

Papers for other journals

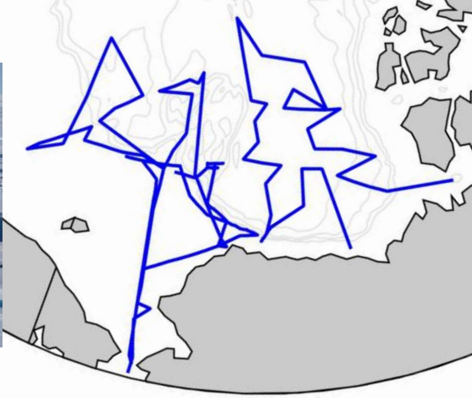
6. **Itoh et al.**, Interannual changes in the Barrow Canyon transports of volume, heat and fresh water between 2000 and 2022 and its impact on the properties of Pacific waters in the Arctic Basins.
7. **Nishino and Jung et al.**, Beaufort Gyre shrinkage and Atlantification induced an anomalous biogeochemical event in the western Arctic Ocean (submitted to Nature communications).
8. **Kumamoto et al.**, Temporal changes in ^{137}Cs and ^{129}I in the Canada Basin in the Arctic Ocean (To be submitted to Polar Science).
9. **Kumamoto et al.**, Variation factor of polycyclic aromatic hydrocarbons in surface seawater of the Arctic Ocean during 2019-2022.

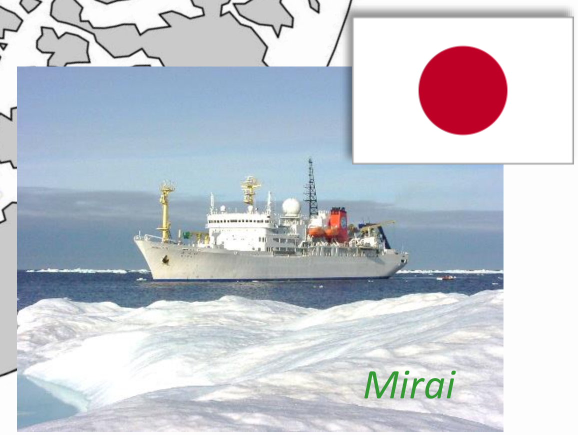
Synthesis paper I: SAS collaborative cruises in 2020 by Korea, Japan, and Canada/US

Hydrographic stations

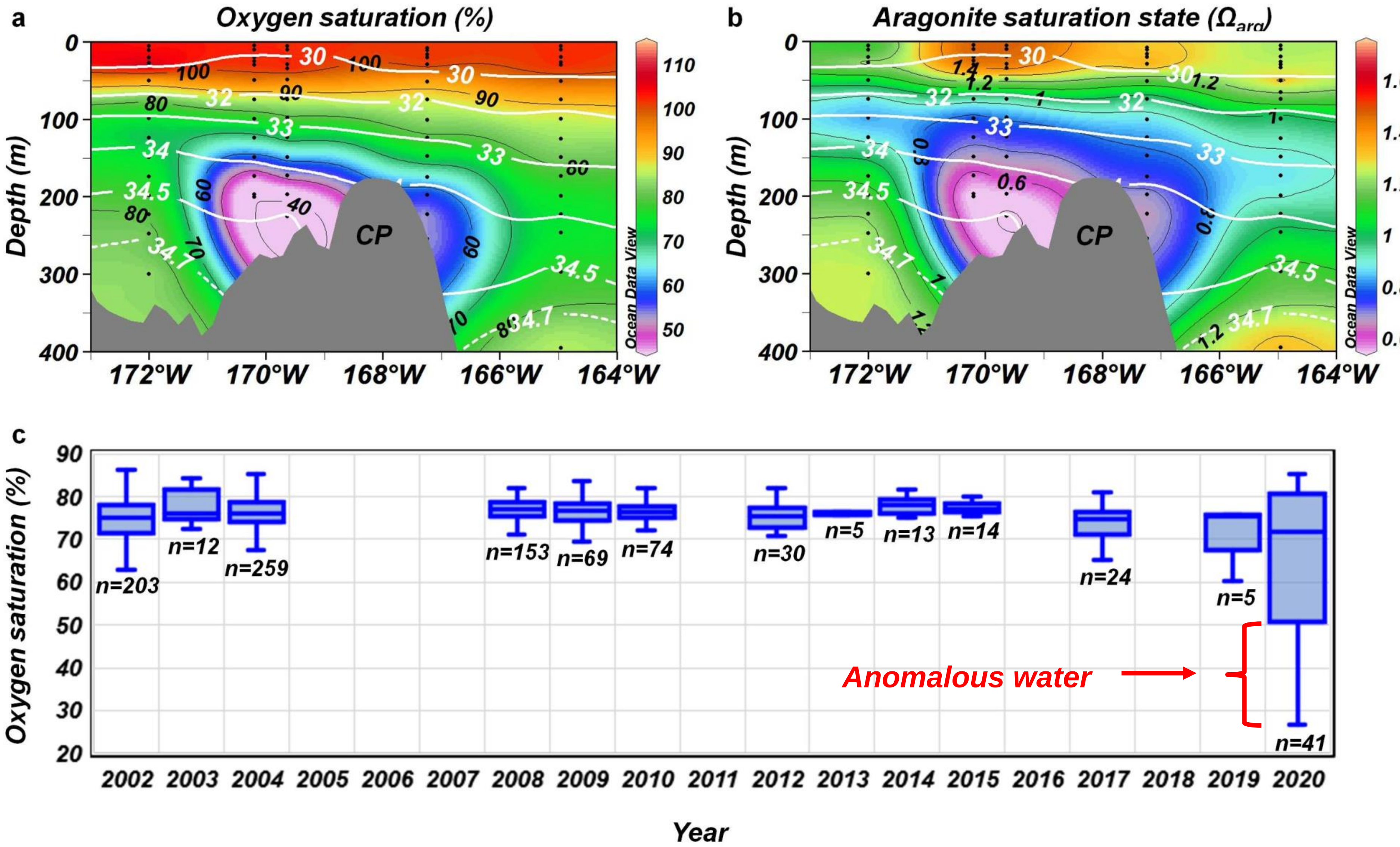


Nishino and Jung et al., Beaufort Gyre shrinkage and Atlantification induced an anomalous biogeochamical event in the western Arctic Ocean (submitted to Nature communications).

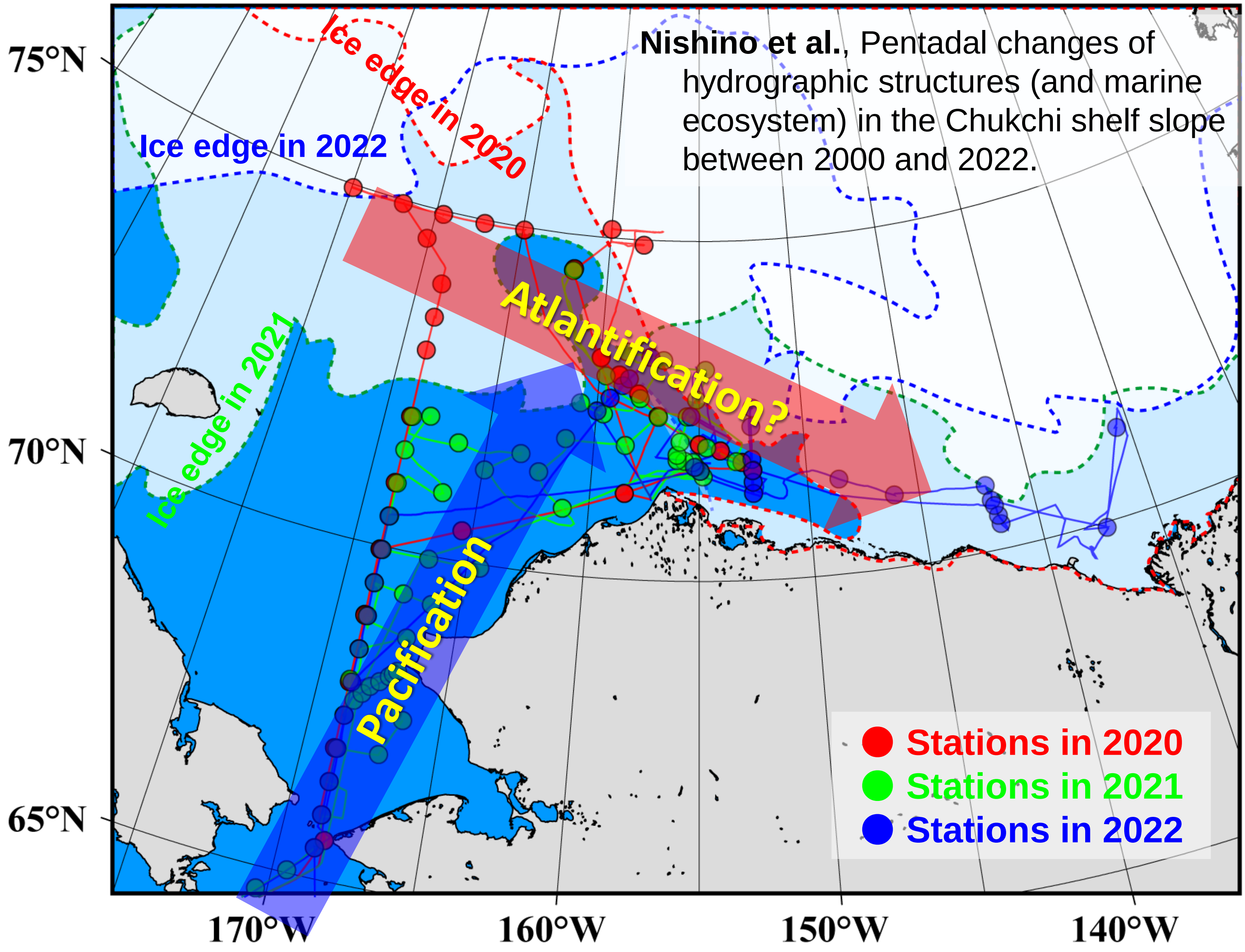




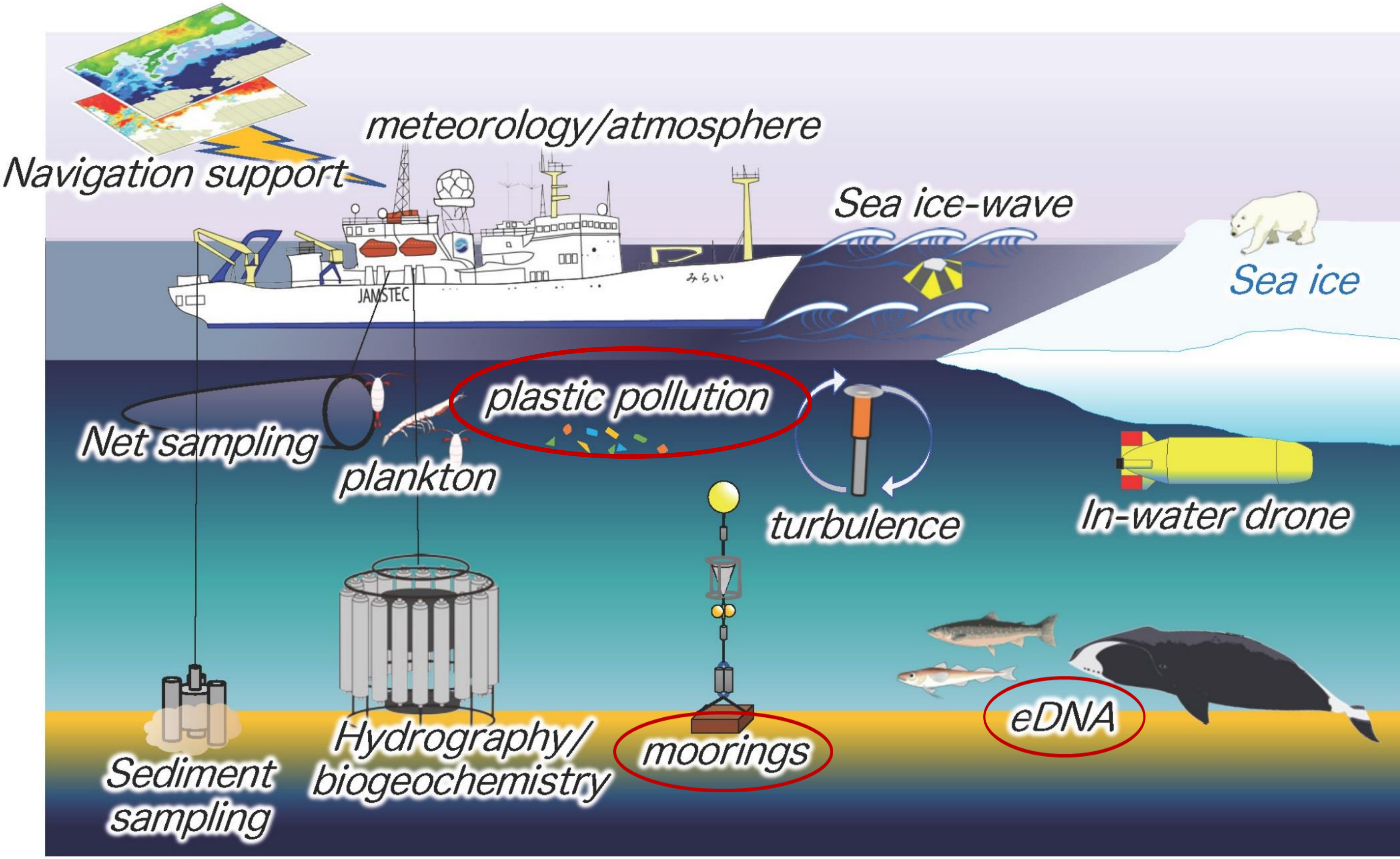
Low Oxy and highly acidified water on the Chukchi Plateau



Synthesis paper II: Atlantification and Pacification in the southern Canada Basin studied by accumulated Mirai data

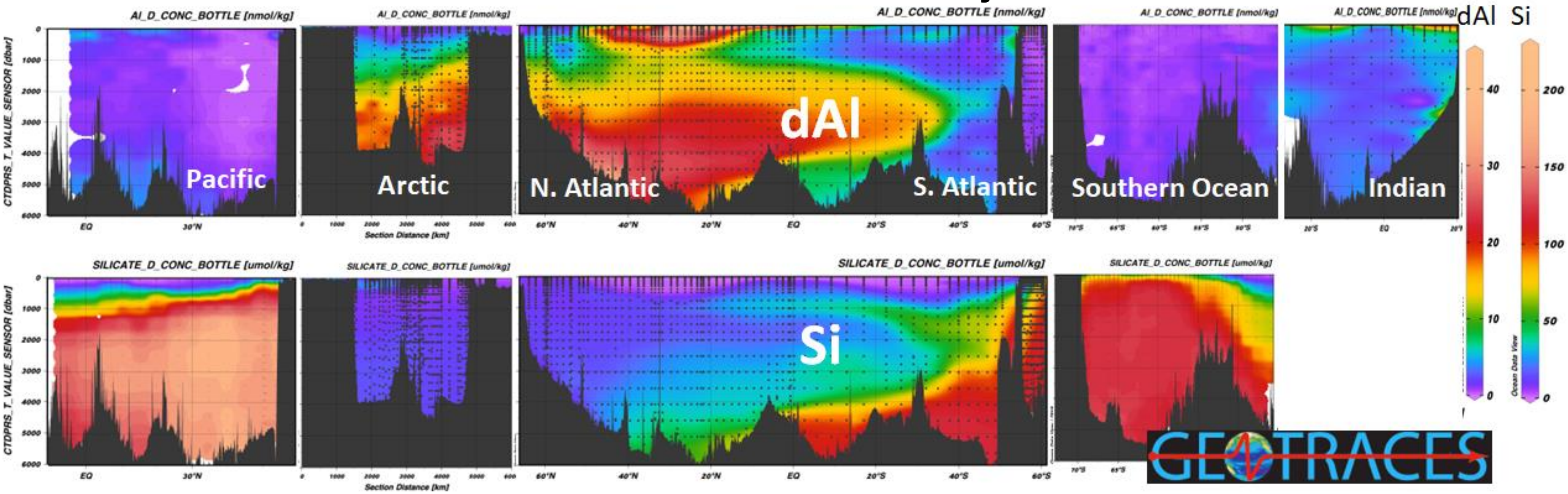


Parameters outside of the core parameters



Dissolved Al is a potential tool to evaluate dust effects, sediment-water interface processes, and water circulation

Dissolved Al and Si sections across major ocean basins



[Courtesy of Dr. Mariko Hatta]

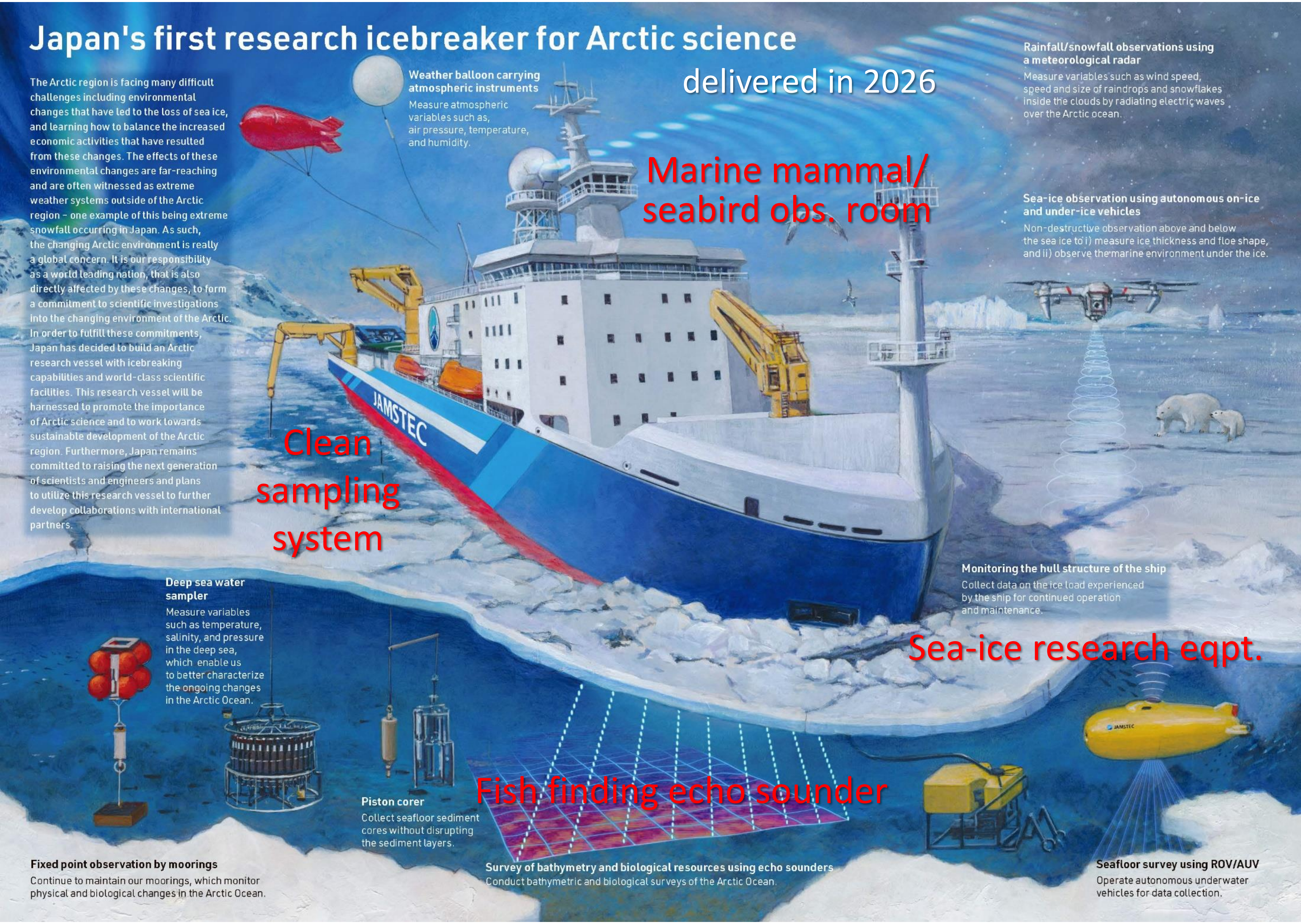
GEOTRACES KEY PARAMETERS

– micronutrients essential to life in the ocean (e.g. Fe, Zn, Cd, Cu)

– tracers of modern processes in the ocean (e.g. Al, Mn, $\delta^{15}N$)

– significantly perturbed by human activities (e.g. Pb)

– used as proxies to reconstruct the past (e.g. ^{231}Pa, ^{230}Th, Nd isotopes)


Japan's first research icebreaker for Arctic science
delivered in 2026
The Arctic region is facing many difficult challenges including environmental changes that have led to the loss of sea ice, and learning how to balance the increased economic activities that have resulted from these changes. The effects of these environmental changes are far-reaching and are often witnessed as extreme weather systems outside of the Arctic region – one example of this being extreme snowfall occurring in Japan. As such, the changing Arctic environment is really a global concern. It is our responsibility as a world leading nation, that is also directly affected by these changes, to form a commitment to scientific investigations into the changing environment of the Arctic. In order to fulfill these commitments, Japan has decided to build an Arctic research vessel with icebreaking capabilities and world-class scientific facilities. This research vessel will be harnessed to promote the importance of Arctic science and to work towards sustainable development of the Arctic region. Furthermore, Japan remains committed to raising the next generation of scientists and engineers and plans to utilize this research vessel to further develop collaborations with international partners.
Weather balloon carrying atmospheric instruments
Measure atmospheric variables such as, air pressure, temperature, and humidity.
Rainfall/snowfall observations using a meteorological radar
Measure variables such as wind speed, speed and size of raindrops and snowflakes inside the clouds by radiating electric waves over the Arctic ocean.
Marine mammal/ seabird obs. room
Sea-ice observation using autonomous on-ice and under-ice vehicles
Non-destructive observation above and below the sea ice to i) measure ice thickness and floe shape, and ii) observe the marine environment under the ice.
JAMSTEC
Clean sampling system
Monitoring the hull structure of the ship
Collect data on the ice load experienced by the ship for continued operation and maintenance.
Sea-ice research eqpt.
Deep sea water sampler
Measure variables such as temperature, salinity, and pressure in the deep sea, which enable us to better characterize the ongoing changes in the Arctic Ocean.
Piston corer
Collect seafloor sediment cores without disrupting the sediment layers.
Fish finding echo sounder
Fixed point observation by moorings
Continue to maintain our moorings, which monitor physical and biological changes in the Arctic Ocean.
Survey of bathymetry and biological resources using echo sounders
Conduct bathymetric and biological surveys of the Arctic Ocean.
Seafloor survey using ROV/AUV
Operate autonomous underwater vehicles for data collection.