Pacific Arctic Group 2019 Fall Meeting
October 14-16, 2019
Hangzhou Jinxi Hotel
Hangzhou, Zhejiang Province, China

Report of PAG endorsed projects and proposal for new activities

Central Arctic Ocean

Shigeto Nishino

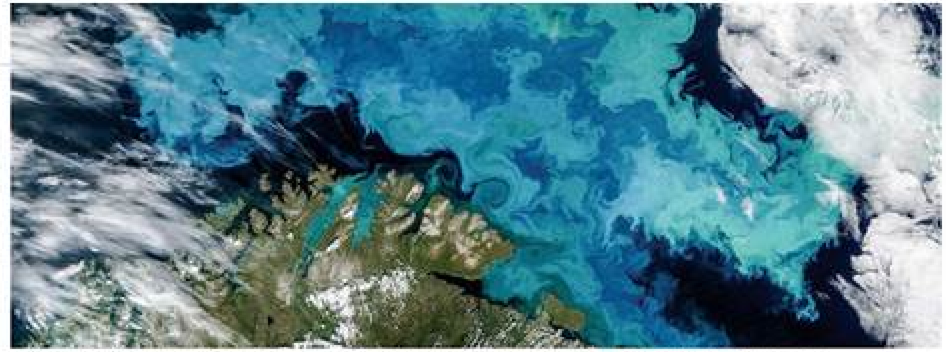
Agreement to prevent unregulated high seas fisheries in the central Arctic Ocean

Hoag, *Science*, 2017

3 October 2018:
The agreement was signed in Ilulissat, Greenland.

The parties:
Canada, Denmark, Norway, Russia, the United States, China, EU, Iceland, Japan, and South Korea

No commercial fishing in the high seas in the coming 16 years



In a boon for fish stocks, the Barents Sea last year saw a steep rise in photosynthesis by phytoplankton (blue-green bloom above) and other organisms.

CLIMATE CHANGE

Nations put science before fishing in the Arctic

Historic fishing ban gives scientists time to probe ecology as northern waters warm

By **Hannah Hoag**

Nine nations and the European Union have reached a deal to place the central Arctic Ocean (CAO) off-limits to commercial fishers for at least the next 16 years. The pact, announced last week, will give scientists time to better understand the region's marine ecology—and the effects of climate change—before receding sea ice opens the way to widespread fishing.

"There is no other high seas area where we've decided to do the science first," says Scott Highleyman, vice president of conservation policy and programs at the Ocean Conservancy in Washington, D.C., who was part of the U.S. delegation involved in the negotiations. "It's a great example of putting the precautionary principle into action."

The deal to protect 2.8 million square kilometers of international waters in the Arctic was reached after six meetings over 2 years. The parties include the five nations with Arctic coastlines—Canada, Denmark (representing Greenland), Norway, Russia, and the United States—and others that have fishing fleets interested in operating in the region.

Thus far, thick ice and uncertain fish stocks have kept commercial fishing vessels out of the CAO, but the region is becoming increasingly accessible. In recent summers, as much as 40% of the CAO has been open water, mostly north of Alaska and Russia, over the Chukchi Plateau.

As the summer sea ice becomes thinner and its edge retreats northward, more sunlight is penetrating the water, increasing production of plankton, the base of the Arctic food web. These sun-fed plankton are gobbled up by Arctic cod, which in turn are hunted by animals higher up the food chain, including seals, polar bears, and humans. Some parts of the Arctic Ocean's adjacent seas, such as the Barents Sea (off the northern coasts of Russia and Norway), saw steep increases in primary production—photosynthesis by plankton and other organisms—in 2016, approaching 35% above the 2003 to 2015 average, according to the U.S. National Oceanic and Atmospheric Administration.

Farther north, the state of fish stocks in the CAO is unknown, but existing international law does not prohibit fishing there. Some researchers, environmental groups, and policymakers fear unregulated commercial fishing in the CAO could harm the fragile and rapidly changing marine ecosystem. In the late 1980s, fishing trawlers from Japan, China, and elsewhere crowded the international waters in the Bering Sea between Russia and the United States and removed millions of tons of pollock. By the early 1990s, the pollock population had crashed. It has still not recovered, says David Benton, a member of the U.S. Arctic Research Commission on Admiralty Island in Alaska.

In 2012, some 2000 scientists called for a fishing moratorium in the CAO to prevent a similar catastrophe. Their efforts were a success: By 2015, five Arctic nations vowed to bar their own fishing vessels from the area. But the moratorium left the area open to other large global fishing fleets. Later that year, delegations from other fishing nations—Japan, China, South Korea, and Iceland—as well as the European Union joined the discussions to negotiate a broader new agreement. "The delegations saw the wisdom in waiting [to start commercial fishing] until there was enough science and management in place," says David Balton, deputy assistant secretary for oceans and fisheries at the U.S. Department of State in Washington, D.C., who has chaired the negotiations since 2015. The deal will stand for 16 years, and will renew automatically every 5 years after that unless a country objects or until science-based fisheries quota and rules are put in place.

In addition to closing the area to fishing, the delegations have agreed to a research and monitoring program to identify species, their abundance, predator-prey relationships, and the pressures they face, including climate change. It hasn't been worked out yet how the program would be funded and managed, Balton says.

For now, reaching the CAO to study its marine ecology requires significant icebreaking capacity, says Peter Harrison, an Arctic policy and fisheries expert at Queen's University in Kingston, Canada, and former deputy minister of Canada's Department of Fisheries and Oceans. Although the United States and Canada have struggled to maintain and expand their icebreaking fleets, other signatories, including China, have that capacity.

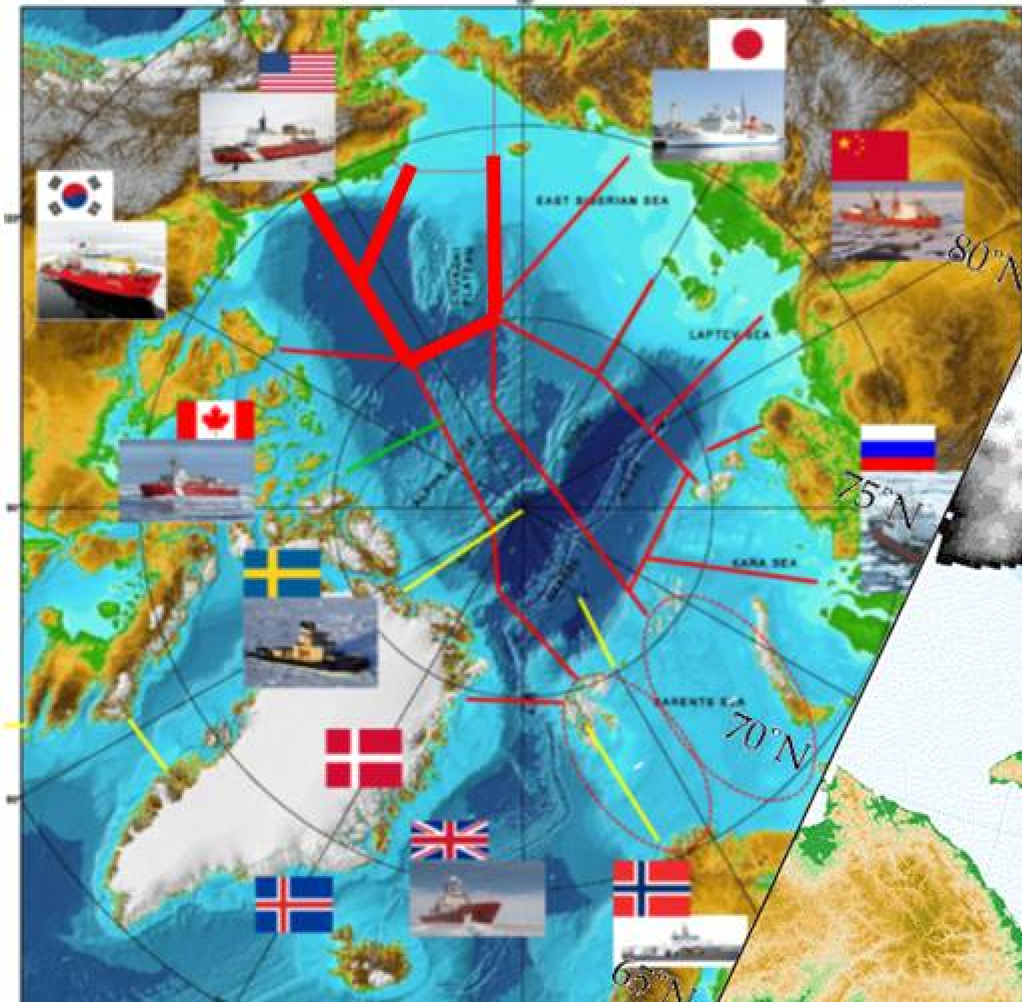
Harrison argues that the signatories should create a new multinational science organization focused on the CAO. It could set science priorities, share and analyze the data collected, and provide advice on the state of the CAO's fish stocks. "If you say commercial fishing will not take place until there is sufficient science, going forward, the science will play a very significant role," he says. ■

Hannah Hoag is a science journalist in Toronto, Canada.

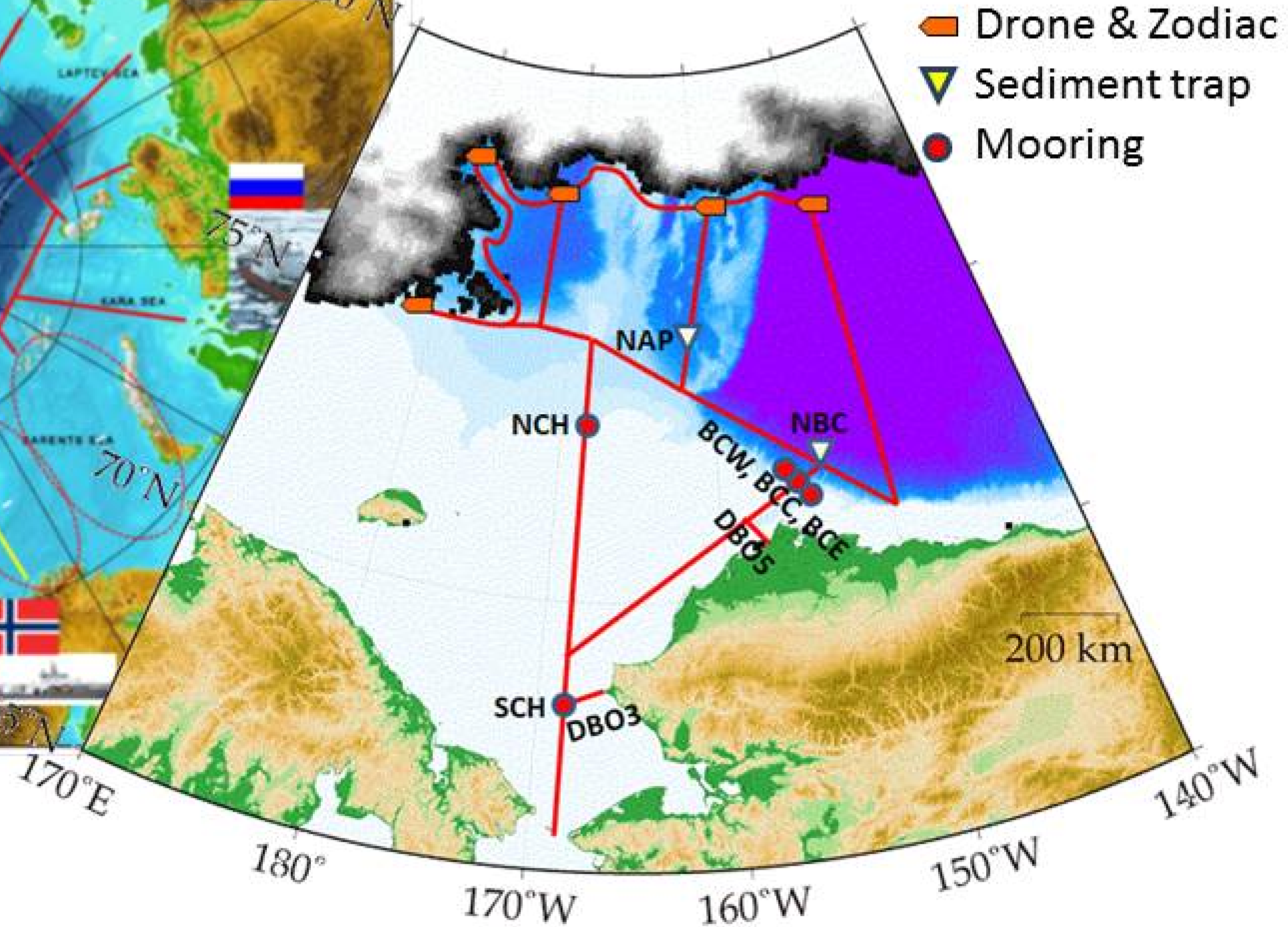
Fishable area in the Arctic international waters

Planned R/V *Mirai* Arctic Ocean cruises in 2020 and 2021

2020: SAS ship-based sampling campaign



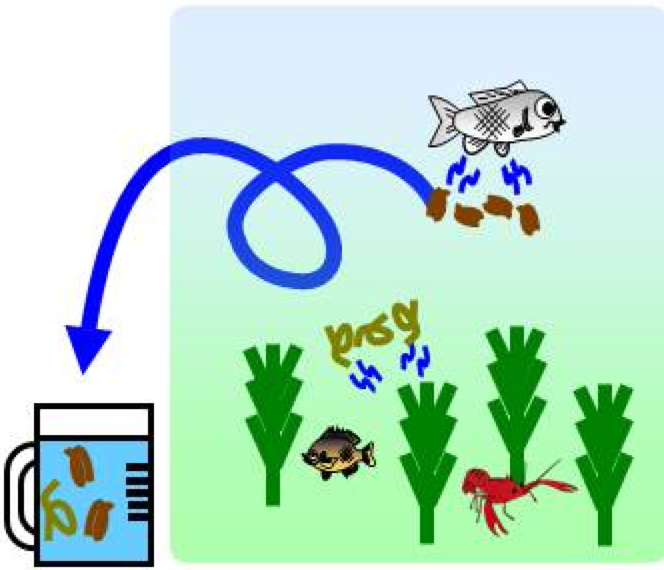
2021: SAS with intensive ice-edge survey



Snow
Ice
Nutrients
Dark
Pre-bloom,
net heterotrophic
No interaction
Late Spring/
Early Summer
Strong ice-pelagic-benthic
coupling

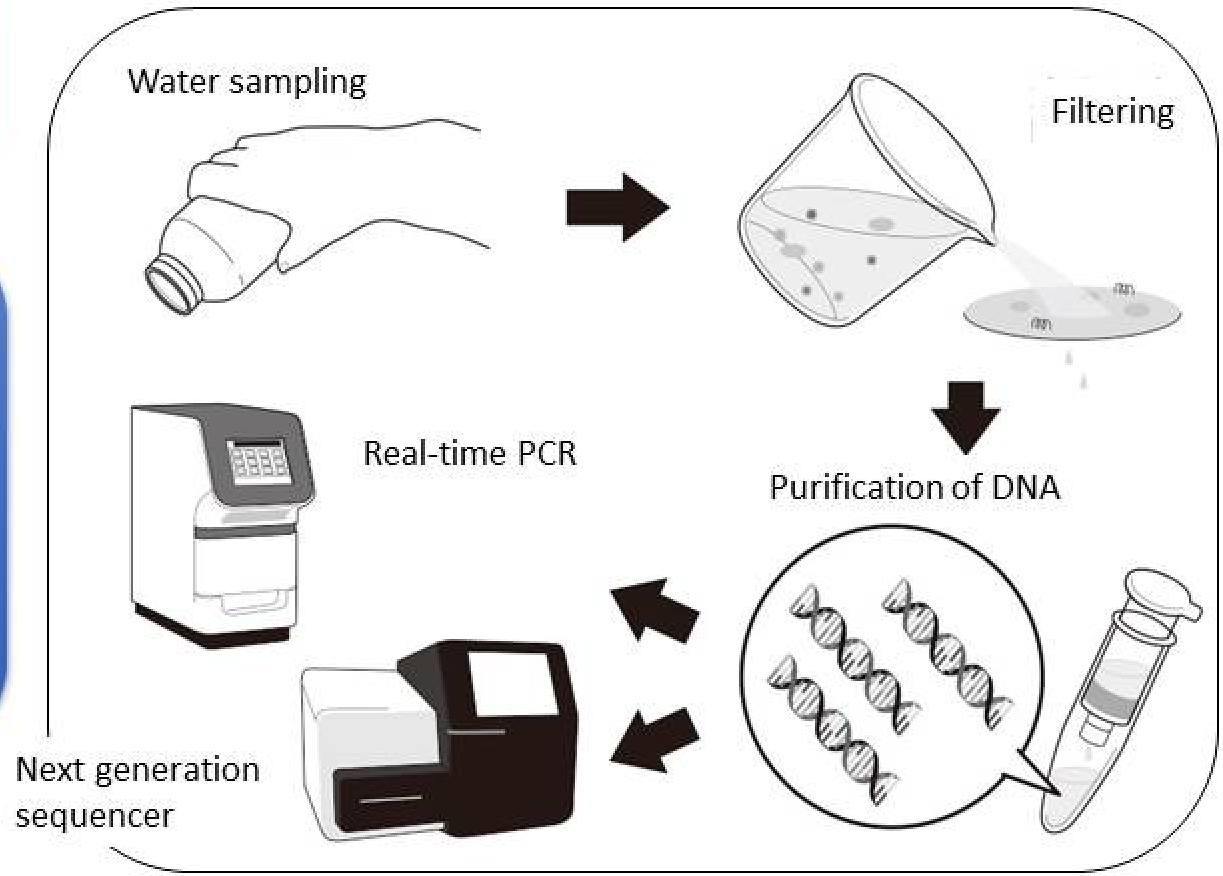
[SWIPA, 2017]

Environmental DNA is DNA in water or soil

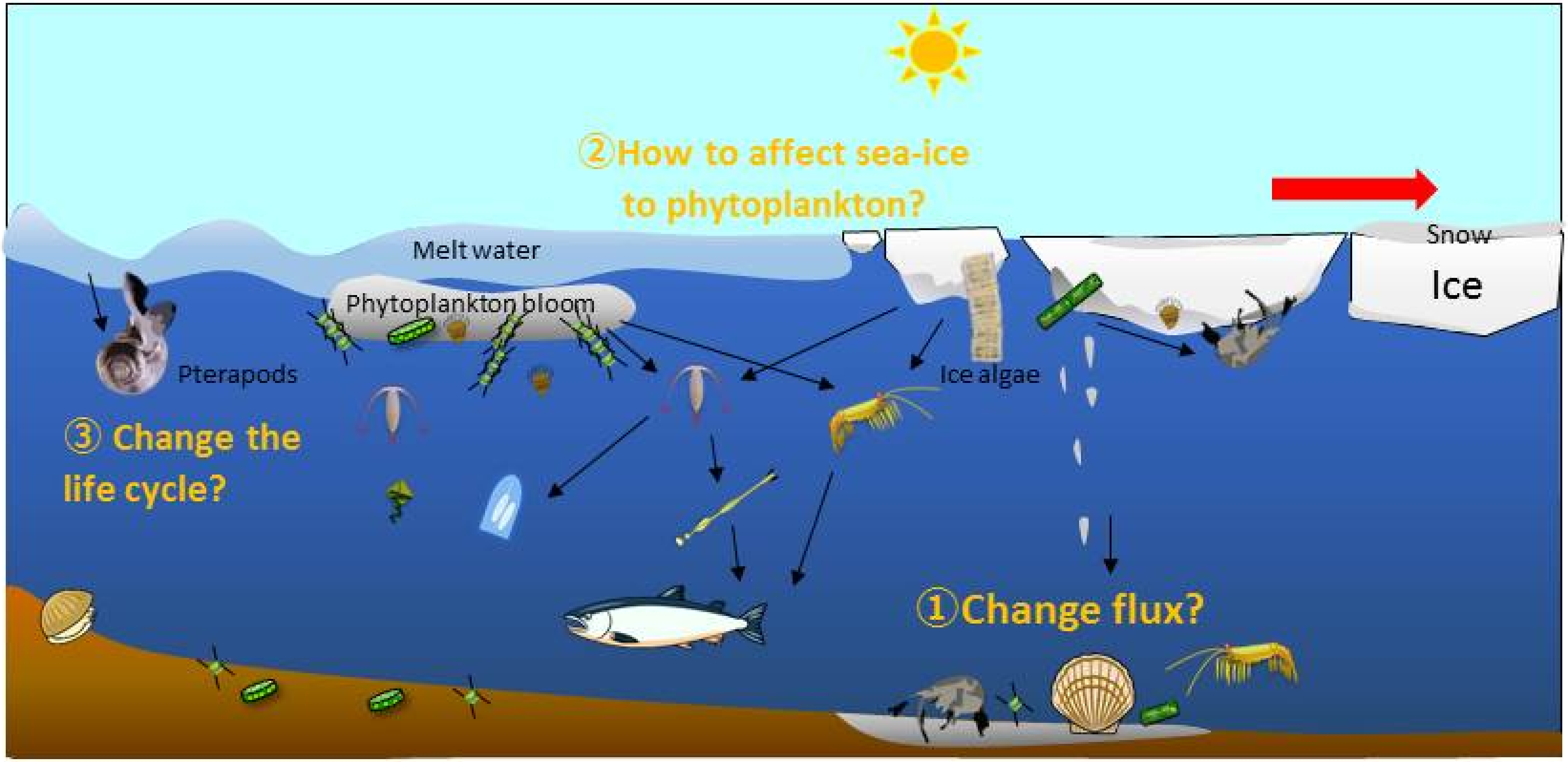


We estimate distribution and biomass from environmental DNA in the water.

Collecting and analysis method



Study motivation



Objects

①How change the ice-associated phytoplankton and their carbon flux?

②How to affect the sea-ice reduction on phytoplankton species composition and size spectra?

③How change the life cycle (phenology) of zooplankton?

Materials and Methods

①How change the ice-associated phytoplankton and their carbon flux?

Several type of sea-ice (ice core is better) will be collected, melted on board and preserved. Ice algae in the samples will be enumerated with size measurement.

②How to affect the sea-ice reduction on phytoplankton species composition and size spectra?

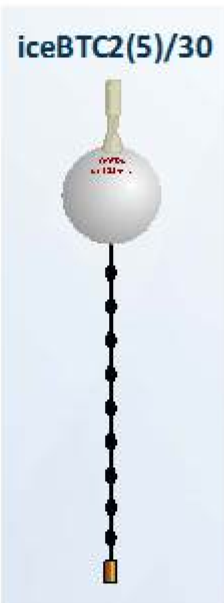
Water samples will be collected at under sea-ice and open water, and compare the phytoplankton species composition and size spectra.

③How change the life cycle (phenology) of zooplankton?

Zooplankton will be collected by vertical hauls of plankton net from sea-ice and research vessel, respectively. The population structure and some biological parameters (e.g., lipid volume, gonad maturation etc.) will be compared between under sea-ice and open water.

Sea ice physics, chemical and biological properties

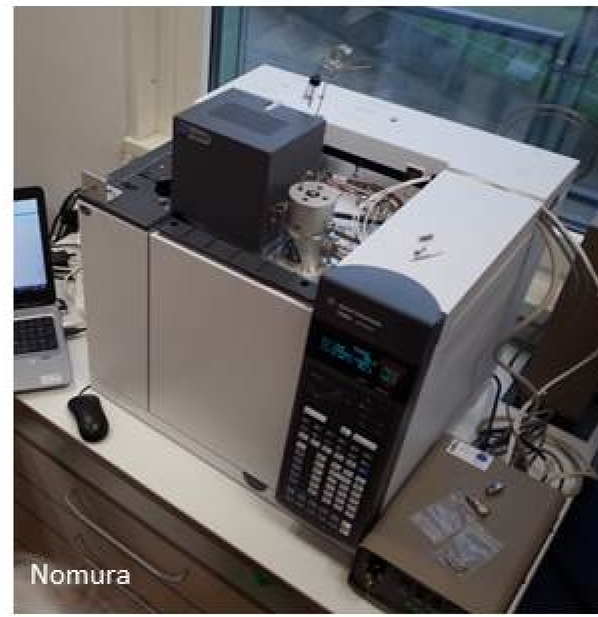
Ice thickness and ice temperature measurement by sensors. Sea ice core sampling to analysis.



Ice temp sensor
Marlin-Yug Ltd

Ice coring

Ice melting in gas tight bag



GC for gas@AWI

Greenhous gas (e.g. CH_4) measurement within sea ice

Contribution to international programs

- ✓ Establish the method for sea ice biogeochemistry (SCOR ECV-Ice/BEPSII).
- ✓ Comparison with international campaign (e.g. MOSAiC).

SCOR WG152
ECV-Ice
Since 2016

BEPSII
BIOGEOCHEMICAL EXCHANGE PROCESSES AT SEA ICE INTERFACES

Facilities for sea ice research

Use of Ice breaker, Ice camp, base in foreign country for sea ice research.

Hendricks

Nomura

These experiences will contribute to future Japanese activities for sea ice research.

Primary Production Mapping

Features of the Arctic phytoplankton

- Adapted to the seasonally variable radiation (midnight-sun&polar-night)
- Large phytoplankton size (highly packaged)
- Large amount (& recently increasing) of terrestrial water discharge
  → competition for light with CDOM & detritus

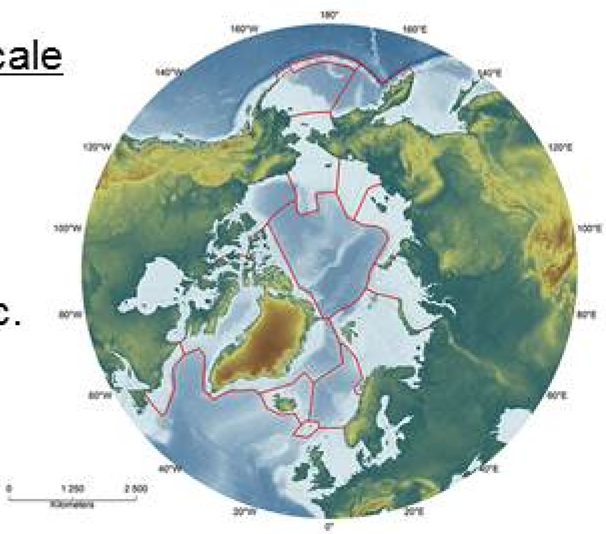
Robust algorithm to derive primary production for the Arctic Ocean from space

<u>Mapping and manage satellite PP with optional spatio-temporal scale</u>

Temporal option
→*bloom term / post-bloom term / annual cumulative PP, etc.*
Spatial option
→*Geographic sectors /* Large Marine Ecosystem / specific site, etc.

Other mapping products for the Arctic

- ✓ Chlorophyll-a
- ✓ Phytoplankton community composition
- ✓ Sea surface temperature
- ✓ Open water period (secondary products of sea ice)

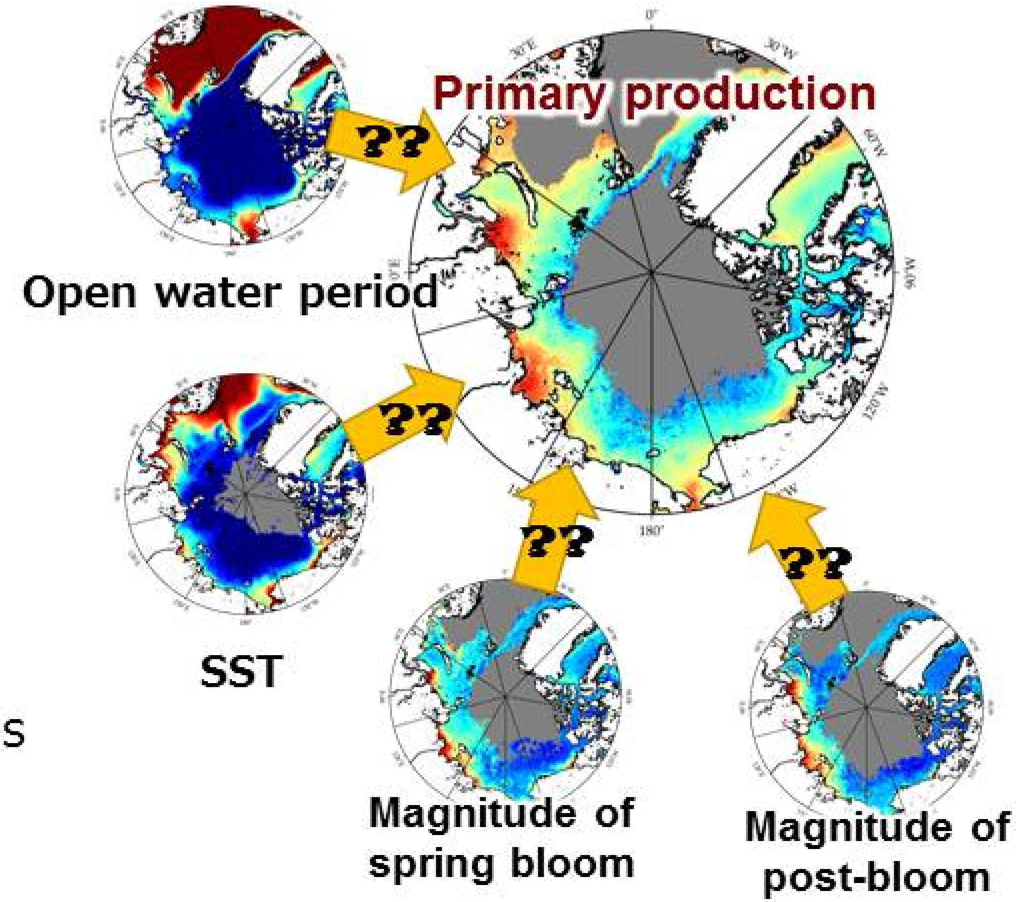


Large Marine Ecosystem
[PAME, 2013]

Primary Production Mapping

Regional/seasonal comprehension of controlling factors of primary production

- Transdisciplinary studies of natural science (physical-, ecological-, biogeochemical sciences)
- collaboration with socio-economical sciences
  →management of bio-resources and marine ecosystem, etc.



Marine Ecological Vulnerability Assessment

- Pan-Arctic Monitoring using the state-of-the-art satellite observation technology
- Translation of scientific data into policy-friendly information

Environmental/Ecological data from satellites

X

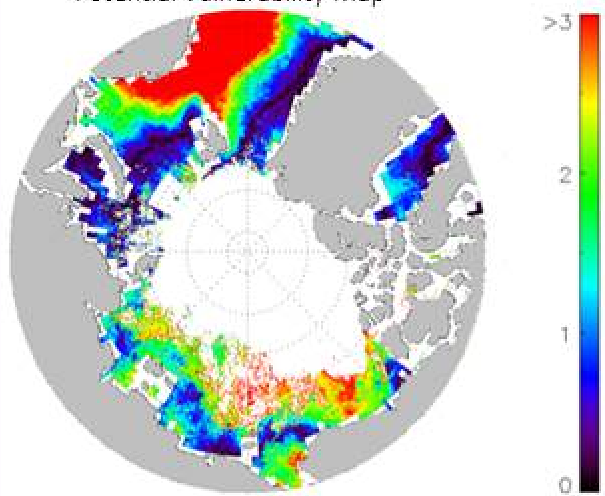
RISESAT: a university-built microsatellite carrying Ocean Observation Camera (OOC)

Satellite Data Receiving Station at the Arctic Research Center, Hokkaido University

Translation

Expected Output

Potential Vulnerability Map



Larger potential vulnerability

Smaller potential vulnerability

Note: This particular figure is not an actual result, and is only for schematic presentation.