Synoptic Arctic Survey 2022 Spring Meeting, March 31st, 2022

Korea’s contribution to SAS: Araon 2020 and 2021 cruises

Kyoung-Ho Cho, Eun-Jin Yang, Jinyoung Jung, Hyoung Sul La, Sung-Ho Kang, and SAS-Korea Team

Division of Ocean Sciences
Korea Polar Research Institute, Korea

KOPRI KIMST 해양수산부

Synoptic Arctic Survey (SAS) – Korea

A single, overarching question on a Pan-Arctic scale focused in SAS:

“What are the present state and major ongoing transformations of the Arctic marine system?”

– SAS Science & Implementation Plan –

Three focal areas in SAS

- **Physical Drivers**
- **Ecosystem Response**
- **Carbon Cycle & Ocean Acidification**

9 Research Questions

Box 1: Research questions in the three focal areas

Physical Drivers:

RQ1. How are Arctic Ocean water masses and circulation patterns responding to changes in sea ice properties, and atmospheric, advective and freshwater forcing?

RQ2. What are the states of, and changes in, heat and freshwater budgets in the Arctic region?

RQ3. What are the changes in water mass sources, sinks and transformations?

Ecosystem Response:

RQ4: How does primary production and associated availability of nutrients vary between Arctic regions?

RQ5: Does northward range expansion of subarctic species vary regionally and are any of these species likely to establish permanent populations in Arctic regions?

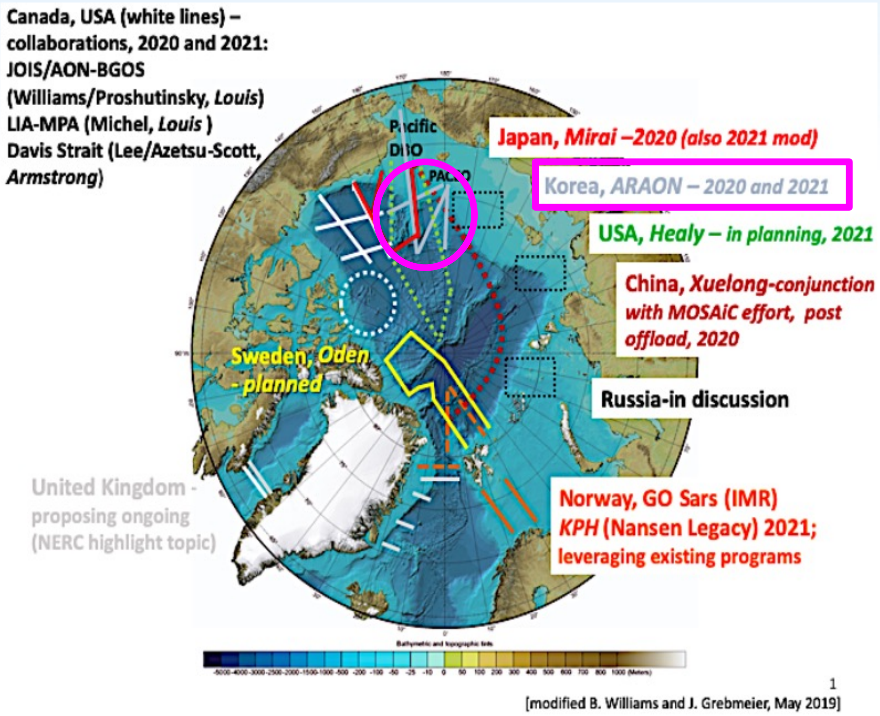
RQ6: How does biomass flow vary across regional ecosystems of the Arctic?

Carbon Cycle and Ocean Acidification:

RQ7: What is the contribution of the Arctic Ocean to maintaining the global ocean carbon dioxide reservoir and uptake?

RQ8: What are the input and fate of terrestrial and subsea carbon to the Arctic Ocean?

RQ9: What are the magnitude, drivers, and impacts of Ocean Acidification in the different regions of the Arctic?

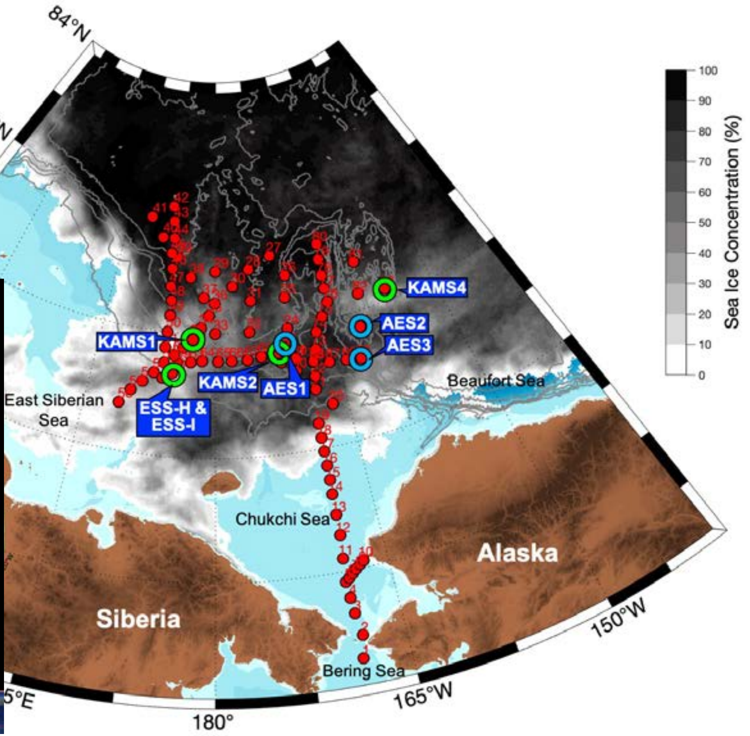


(from the Report of 2019 SAS Workshop held in WHOI, May 15-16, 2019)

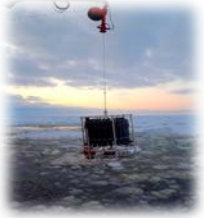
The objective of the SAS-Korea research is to seek the answers to those research questions joining the Arctic cruises and sharing observations and analyses of data.

2020/2021 ARAON Arctic Ocean Cruises

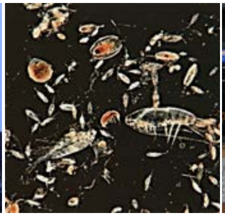
	2020	2021
CTD	88	96
XCTD	16	
Period	08/04-08/31	07/20-08/18

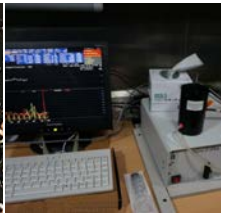


Variables	Responsible	Availability	Affiliation	Contact (e-mail address)
Chemistry and physics				
CTD (Pressure, Temperatire, Salinity)	Kyoung-Ho Cho	A	KOPRI	kcho@kopri.re.kr
Inorganic chemistry (Oxygen, nutrients, DIC, Alkalinity, pH)	Jinyoung Jung	A	KOPRI	jinyoungjung@kopri.re.kr
CFCs and SF_6		N/A		
$\delta^{18}O$ of H_2O	Jinyoung Jung	A	KOPRI	jinyoungjung@kopri.re.kr
Organic chemistry (DOC, POC)	Jinyoung Jung	A	KOPRI	jinyoungjung@kopri.re.kr
CO2 (atmosphere & sea surface)	Jinyoung Jung	A	KOPRI	jinyoungjung@kopri.re.kr
Black Carbon	Jinyoung Jung	A	KOPRI	jinyoungjung@kopri.re.kr
Methane		N/A		
Water column ecosystem				
Phytoplankton (composition, Chl-a, pigment and physiology)	Eunjin Yang	A	KOPRI	ejyang@kopri.re.kr
Zooplankton (micor-, meso-, and macrozooplankton)	Eunjin Yang	A	KOPRI	ejyang@kopri.re.kr
Primary production & nitrogen uptake rates	Youngju Lee	N/A in 2020	KOPRI	yjlee@kopri.re.kr
Bacteria (abundance)	Eunjin Yang	A	KOPRI	ejyang@kopri.re.kr
Virus		N/A		
Ictyhyoplankton and Fish (eDNA)	Eunjin Yang	A	KOPRI	ejyang@kopri.re.kr
Marine mammals		N/A		
Transformation rates (grazing, sinking, respiration)	Eunjin Yang	A	KOPRI	ejyang@kopri.re.kr
Acoustics	Hyoungsul La	A	KOPRI	hsla@kopri.re.kr
Particle flux	Eunjin Yang	A	KOPRI	ejyang@kopri.re.kr
Benthic ecosystem				
Meio- and macrofauna, epifauna		N/A		
Transformation rates (grazing, sinking, respiration)		N/A		
Phytoplankton resting spores		N/A		
Ice studies and Epiontic communities				
Under ice imagies		N/A		
Ice cores/Floating ice (chemical and biological components)	Jinyoung Jung	N/A in 2020	KOPRI	jinyoungjung@kopri.re.kr
Seabirds		N/A		
Modelling (ocean)	Kyoung-Ho Cho	N/A in 2020	KOPRI	kcho@kopri.re.kr


CTD


Nets


Microscopy


Fire

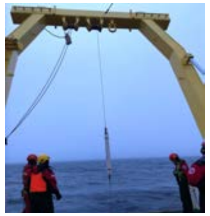

Sediment trap


ADCP


IPS

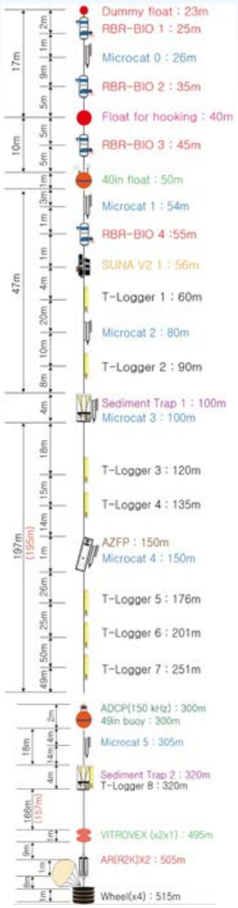

EK80


AZFP

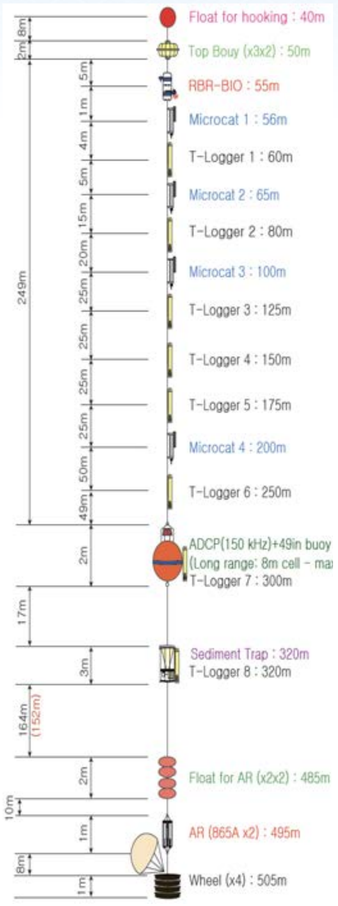

Hydrophone

Korea Arctic Mooring System

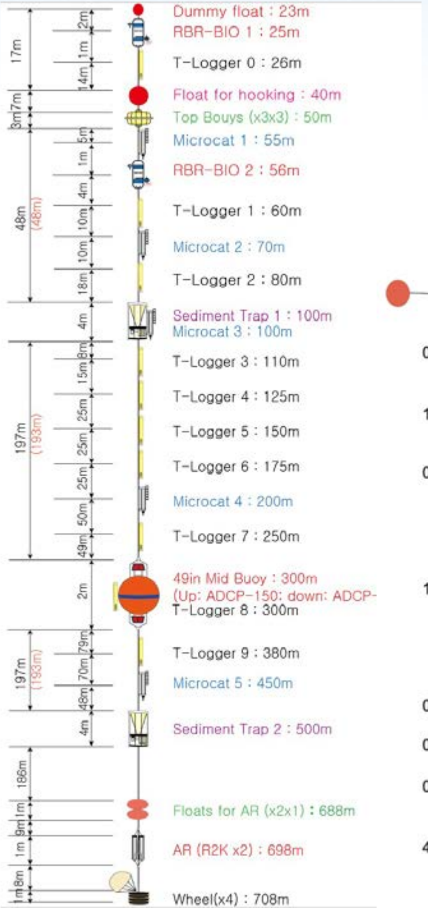
KAMS1-21



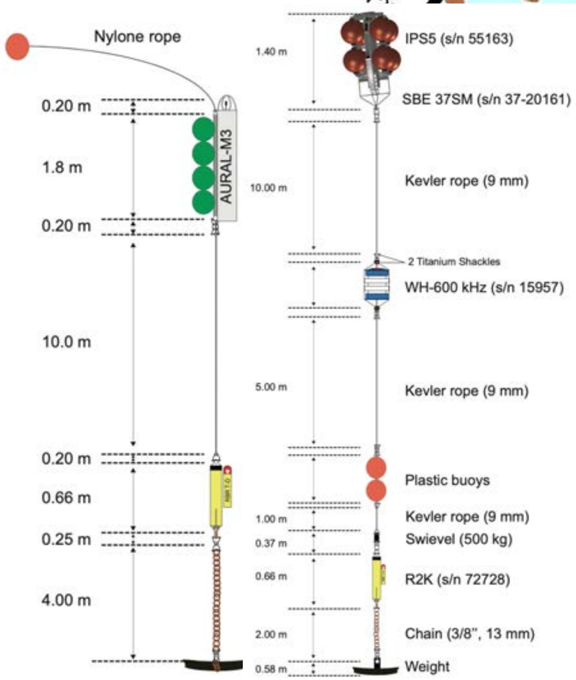
KAMS2-20

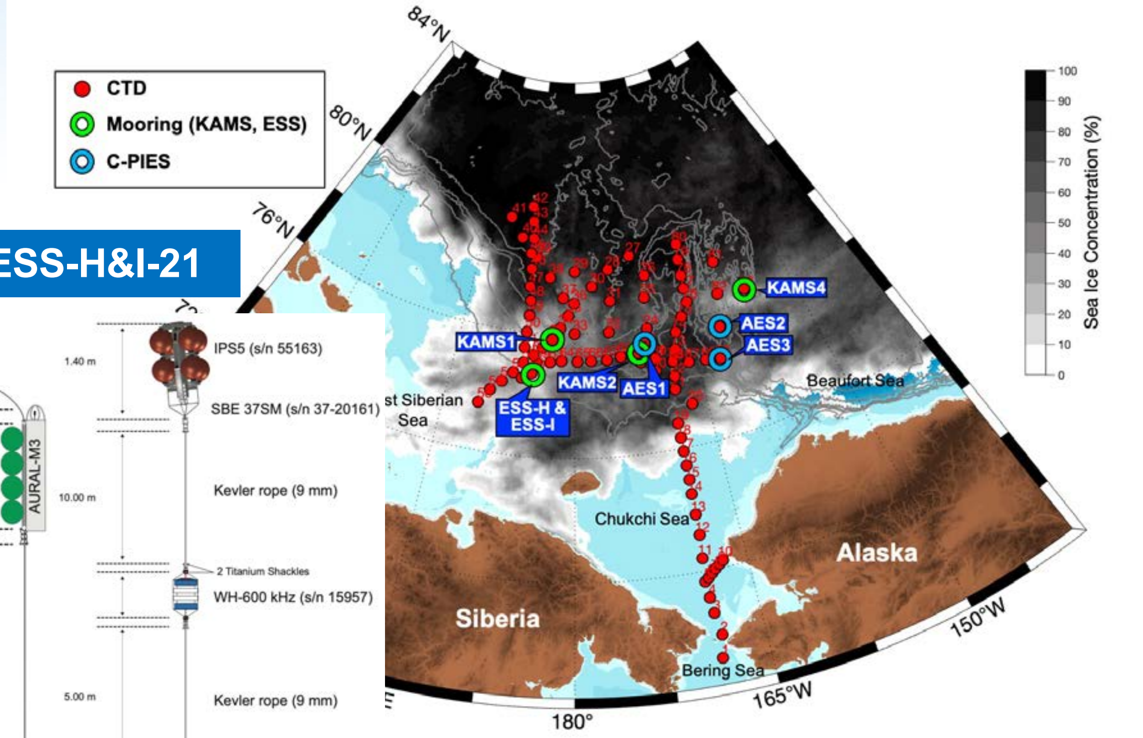


KAMS4-21



ESS-H&I-21



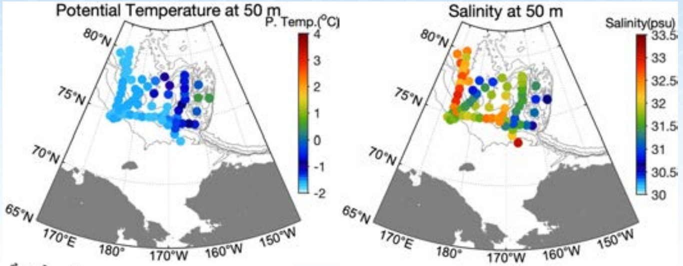


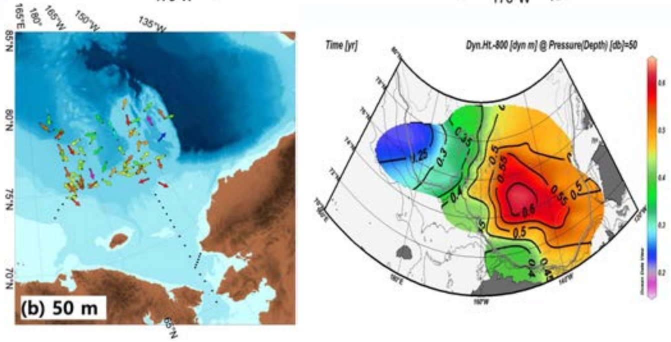
북극해 온난화-해양생태계 변화 감시 및 미래전망 연구

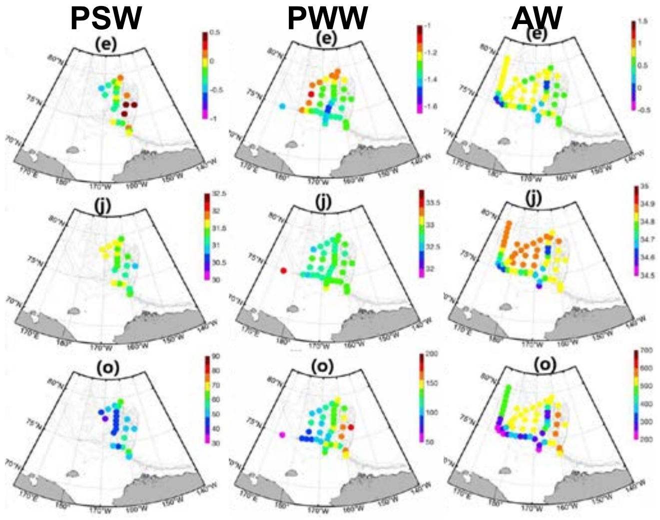
KOPRI KIMST 해양수산부

SAS-Korea Activities in 2020/2021: Physical Oceanographic Study

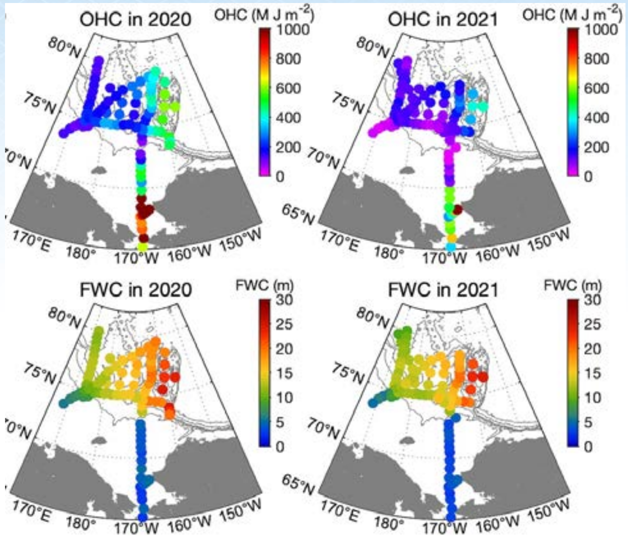
Spatial patterns of water masses & circulation



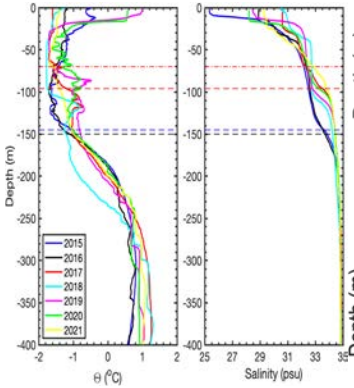


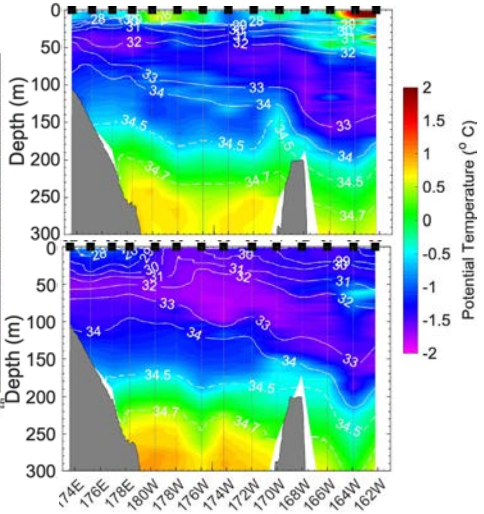


Changes in heat & freshwater contents

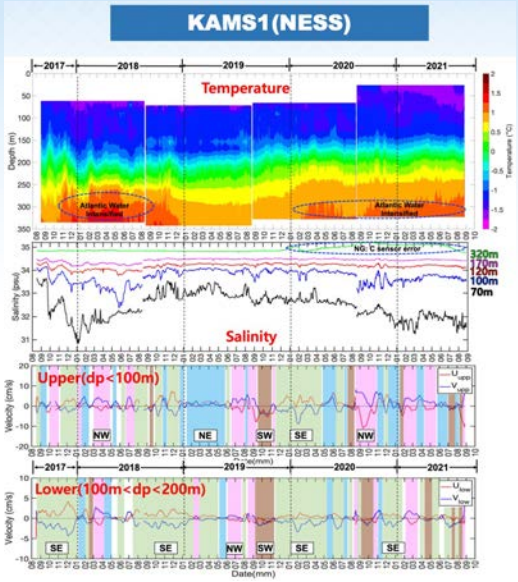


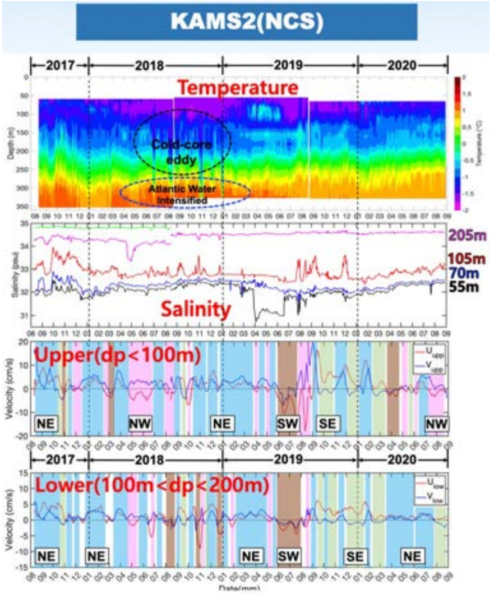
Variations of S & T structures





Long-term variations of T, S, and current



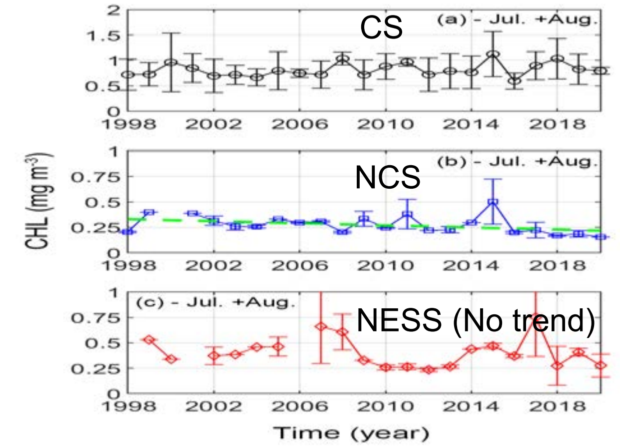


북극해 온난화-해양생태계 변화 감시 및 미래전망 연구

SAS-Korea Activities in 2020/2021: Biological Oceanographic Study

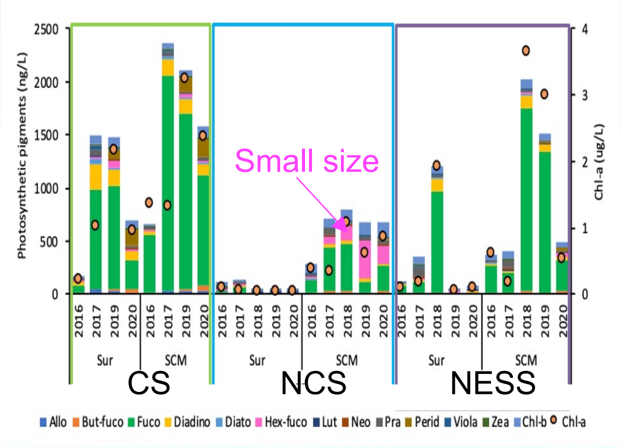
Long-term trend of Chl-*a*

- Different spatial and temporal trend of summer Chl-*a* (1998 – 2020)



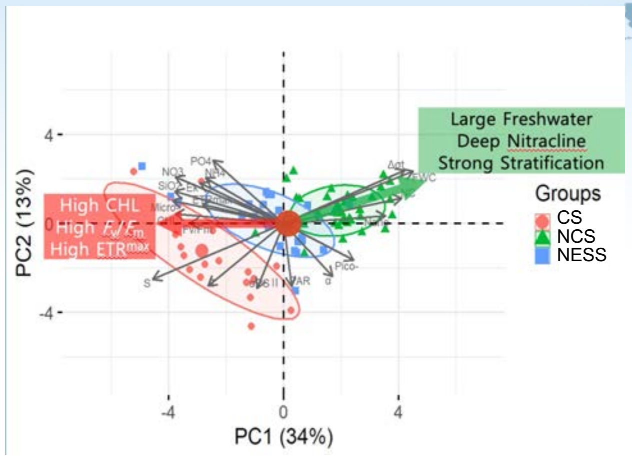
Phytoplankton community

- High biomass and dominant diatoms in the NESS (2016 – 2020)



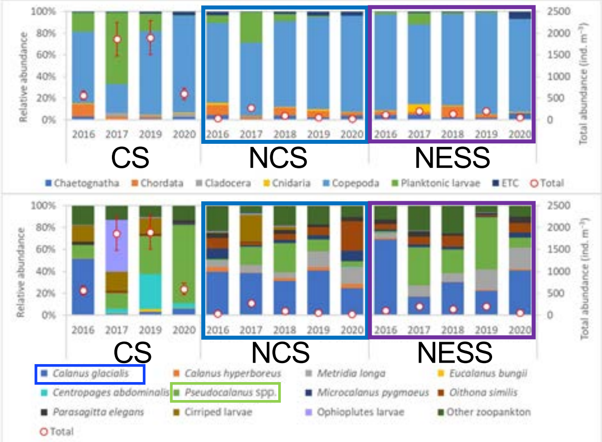
Phytoplankton physiology

- High Fv/Fm in the CS and NESS (2016 – 2020)



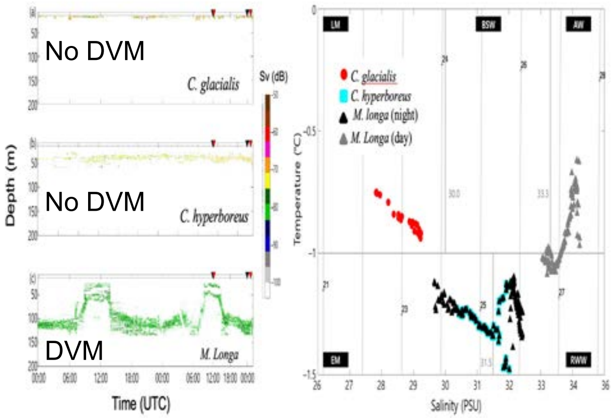
Mesozooplankton community

- *Pseudocalanus* spp. and *C. glacialis* were dominant copepods (2016 - 2020)



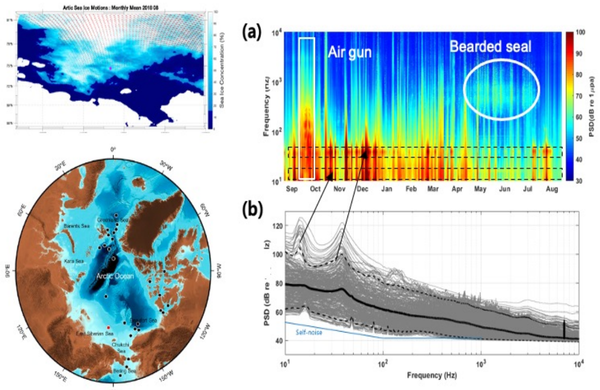
Zooplankton acoustics

- Acoustic identification for three key copepod species



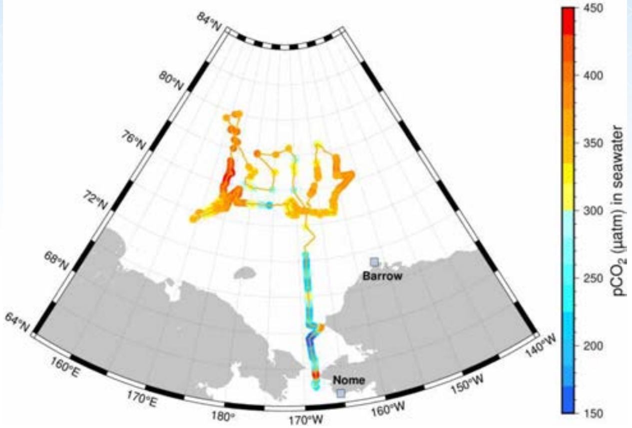
Marine mammals in ESS

- The first soundscape observation around East Siberian Shelf.



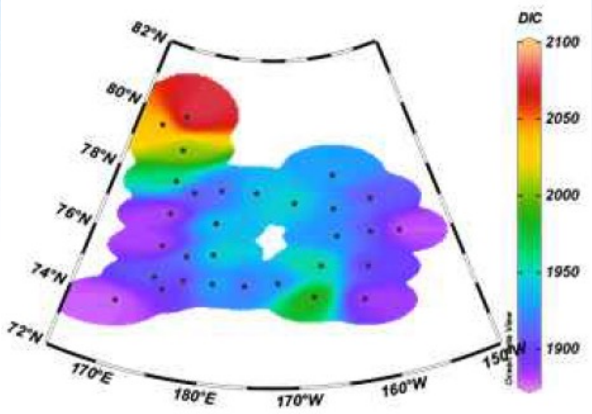
SAS-Korea Activities in 2020/2021: Chemical Oceanographic Study

Spatial and temporal variations of pCO_2



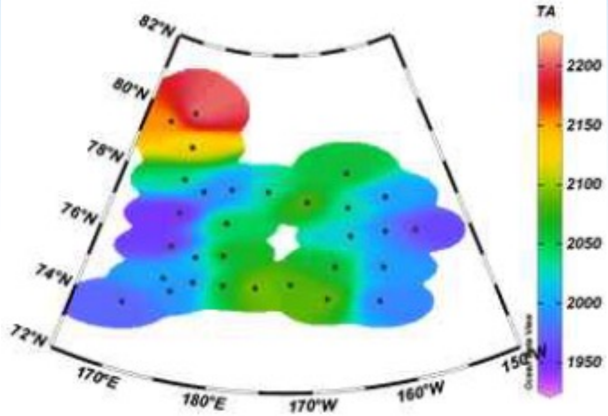
Dissolved pCO_2 along the track

Characteristics of dissolved inorganic carbon (DIC)



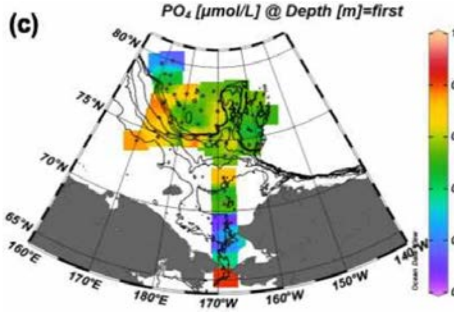
Dissolved inorganic carbon (surface)

Characteristics of total alkalinity (TA) & aragonite saturation

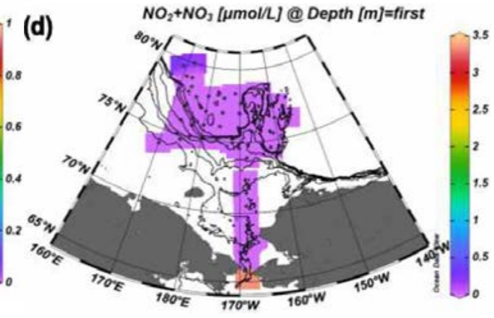


Total alkalinity (surface)

Distributions of nutrients (NH_4, NO_2+NO_3, PO_4 & SiO_2)

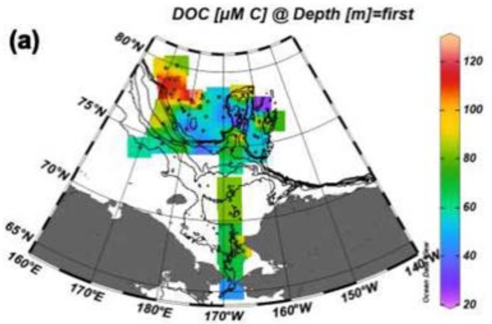


Nutrient (PO_4)



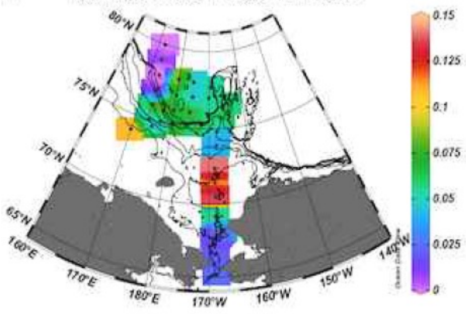
Nutrient (NO_2+NO_3)

Characteristics of dissolved and particulate organic matters (DOM & POM)

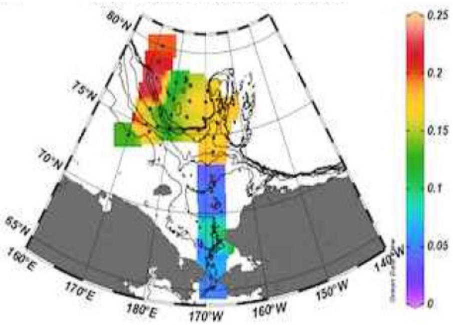


Dissolved organic carbon

Distributions of river water and ice melt water fractions



Ice melt water fraction



River water fraction

KOPRI KIMST 해양수산부

북극해 온난화-해양생태계 변화 감시 및 미래전망 연구

Research papers published since 2021 (selected)

frontiers in Marine Science
ORIGINAL RESEARCH
published: 08 January 2021
doi: 10.3389/fmars.2020.609748

Temporal and Spatial Variations in Particle Fluxes on the Chukchi Sea and East Siberian Sea Slopes From 2017 to 2018

Ho-Jung Kim[1,2], Hyung Jeek Kim[3], Eun-Jin Yang[4], Kyoung-Ho Cho[4], Jinyoung Jung[4], Sung-Ho Kang[4], Kyung-Eun Lee[2], Sosul Cho[1] and Dongseon Kim[1,2]* on behalf of the Collaborative Working Group

Science of the Total Environment 772 (2021) 145542
Contents lists available at ScienceDirect
Science of the Total Environment
journal homepage: www.elsevier.com/locate/scitotenv

Tracing riverine dissolved organic carbon and its transport to the halocline layer in the Chukchi Sea (western Arctic Ocean) using humic-like fluorescence fingerprinting

Jinyoung Jung[a,1], Jin Eui Son[a,b,1], Yun Kyung Lee[b], Kyoung-Ho Cho[a], Youngju Lee[a], Eun Jin Yang[a], Sung-Ho Kang[a], Jin Hur[b,*]
[a] Division of Ocean Sciences, Korea Polar Research Institute, 26, Songdomirae-ro, Yeonsu-gu, Incheon 21990, Republic of Korea
[b] Department of Environment & Energy, 209, Neungdong-ro, Gwangjin-gu, Sejong University, Seoul 05006, Republic of Korea

Geophysical Research Letters
RESEARCH LETTER
10.1029/2020GL090907

Atlantic-Origin Cold Saline Water Intrusion and Shoaling of the Nutricline in the Pacific Arctic

Jinyoung Jung[1,†], Kyoung-Ho Cho[1,†], Taewook Park[1], Eri Yoshizawa[1], Youngju Lee[1], Eun Jin Yang[1], Jong-Ku Gal[1], Sun-Yong Ha[1], Soobin Kim[1,2], Sung-Ho Kang[1], and Jacqueline M. Grebmeier[3]
[1]Division of Polar Ocean Sciences, Korea Polar Research Institute, Incheon, Korea, [2]Department of Oceanography, Inha University, Incheon, Korea, [3]Chesapeake Biological Laboratory, University of Maryland Center for Environmental Science, Solomons, MD, USA
†These authors contributed equally to this work.

Key Points:
- The nutricline shoaling by an intrusion of Atlantic-origin cold saline water was observed in the northwestern Chukchi Sea in 2017
- Pacific-origin nutrients were lifted up to the surface layer by the intrusion of Atlantic-origin cold saline water
- The enhanced cyclonic ocean circulation triggered a pronounced transport of Atlantic-origin cold saline water to the western Arctic Ocean

Supporting Information:
- Supporting Information S1

Correspondence to:
J. Jung and K.-H. Cho,

Abstract Atlantic-origin cold saline water has previously not been considered an important contributor to the nutrient supply in the Pacific Arctic due to the effective insulation by the overlying Pacific-origin waters that separate the surface mixed layer from the deeper Atlantic Water. Based on hydrographic observations in the northwestern Chukchi Sea from 2015 to 2017, we demonstrate that the intrusion of Atlantic-origin cold saline water into the halocline boundary between Pacific and Atlantic-origin waters in 2017 lifted Pacific-origin nutrients up to the surface layer. We find that the cyclonic atmospheric circulation in 2017 was considerably strengthened, leading to lateral intrusions of two bodies of cold halocline water from the Eurasian marginal seas into the northwestern Chukchi Sea. Our results reveal that the intrusions of cold halocline waters caused unprecedented shoaling of the nutricline and anomalously high surface phytoplankton blooms in typically highly oligotrophic surface waters in the region during summer.

JGR Oceans
RESEARCH ARTICLE
10.1029/2021JC018074

Special Section:
Uncovering the hidden links between dynamics, chemical, biogeochemical, and biological processes under the changing Arctic

Spatial and Interannual Patterns of Epipelagic Summer Mesozooplankton Community Structures in the Western Arctic Ocean in 2016–2020

Jee-Hoon Kim[1], Hyoung Sul La[1], Kyoung-Ho Cho[1], Jinyoung Jung[1], Sung-Ho Kang[1], Kanghyun Lee[2], and Eun Jin Yang[1]
[1]Division of Ocean Science, Korea Polar Research Institute, Incheon, Republic of Korea, [2]Biodiversity Research Institute, Marine Act Co., Seoul, Republic of Korea

Key Points:
- This is the first comprehensive Arctic zooplankton study from the Chukchi Sea to the East Siberian Sea
- Water temperature, salinity, and depth have been shown to possess a significant effect on the community structure of the mesozooplankton
- Patterns of interannual mesozooplankton communities have been fluctuated horizontally from south to north on a regional bathymetric basis

Abstract Mesozooplankton play a crucial role as primary or secondary consumers in Arctic ecosystems and are sensitive indicators of environmental changes. This research is the first comprehensive Arctic zooplankton study covering the area ranging from the southern Chukchi Sea (SCS) and the northern Chukchi Sea (NCS) to the East Siberian Sea (ESS). Mesozooplankton samples were collected at 151 stations in the western Arctic Ocean each August from 2016 to 2020. The mesozooplankton abundance of the study area ranged from 9 to 6,172 ind. m^{-3}, and the predominant group was copepods at 7–3,866 ind. m^{-3}, of which *Pseudocalanus* spp. and *Calanus glacialis* were the most abundant copepods. In the SCS, small copepods and meroplankton, such as *Pseudocalanus* spp., Cirripedia larvae, Echinodermata larvae, and *Centropages*

JGR Oceans
RESEARCH ARTICLE
10.1029/2021JC017738

Spatial and Temporal Variations of Aragonite Saturation States in the Surface Waters of the Western Arctic Ocean

D. Kim[1], E.-J. Yang[2], S. Cho[1], H.-J. Kim[1], K.-H. Cho[2], J. Jung[2], and S.-H. Kang[2]
[1]Marine Environmental Research Center, Korea Institute of Ocean Science & Technology, Busan, South Korea, [2]Division of Polar Ocean Science, Korea Polar Research Institute, Incheon, South Korea

Key Points:
- In the Chukchi marginal area (CMA), aragonite saturation state (Ω_{arag}) at the surface was determined mainly by the mixing of seawater and fresh water
- In the East Siberian marginal area, Ω_{arag} was affected by freshwater mixing, biological production, and lateral mixing
- In the near future, most of surface waters in the CMA will be undersaturated with respect to aragonite

Correspondence to:
D. Kim,
dkim@kiost.ac.kr

Citation:
Kim, D., Yang, E.-J., Cho, S., Kim, H.-J.,

Abstract The aragonite saturation state (Ω_{arag}) was determined for the surface waters of the western Arctic Ocean over 3 years, from 2016 to 2018, in an investigation of the present state of acidification of its waters and the main factors controlling the spatial and temporal variations in the surface Ω_{arag}. The study area was divided into the Chukchi marginal area (CMA) and the East Siberian marginal area (ESMA) along a longitude of 180°E. In the CMA, the surface Ω_{arag} during the study period ranged from 0.86 to 1.77, with an average of 1.16, indicating near saturation with respect to aragonite. In the ESMA, the surface Ω_{arag} during the study period ranged from 1.01 to 2.21, with a higher average (1.59) than the CMA. Aragonite undersaturation in the ESMA was not observed during any of the measurement periods, so ocean acidification was less serious there than in the CMA. The surface Ω_{arag} of the CMA was mainly determined by the mixing of seawater and freshwater introduced from rivers and/or sea ice, whereas in the ESMA it was influenced by the mixing of seawater and freshwater but also biological production and lateral mixing.

Geophysical Research Letters
RESEARCH LETTER
10.1029/2021GL093097

Effects of Geophony and Anthrophony on the Underwater Acoustic Environment in the East Siberian Sea, Arctic Ocean

Dong-Gyun Han[1,2], Jongmin Joo[2], Wuju Son[1,3], Kyoung Ho Cho[1], Jee Woong Choi[4], Eun Jin Yang[1], Jeong-Hoon Kim[5], Sung-Ho Kang[1], and Hyoung Sul La[1]
[1]Division of Ocean Sciences, Korea Polar Research Institute, Incheon, Republic of Korea, [2]Policy Support Team, National Air Emission Inventory and Research Center, Cheongju, Republic of Korea, [3]Department of Polar Science, University of Science and Technology, Daejeon, Republic of Korea, [4]Department of Marine Science & Convergence Engineering and Department of Military Information Engineering, Hanyang University ERICA, Ansan, Republic of Korea, [5]Division of Life Sciences, Korea Polar Research Institute, Incheon, Republic of Korea

Key Points:
- The ambient sound level in the East Siberian Sea, showing a negative correlation with the sea ice concentration (SIC), is highest in September
- The ambient sound level increased by 16 dB because of geophony and anthrophony with the reduction in the SIC
- The ambient sound level may increase with accelerated sea ice melting in the future

Contents lists available at ScienceDirect
Journal of Hazardous Materials
journal homepage: www.elsevier.com/locate/jhazmat
Research Paper

Importance of seasonal sea ice in the western Arctic ocean to the Arctic and global microplastic budgets

Seung-Kyu Kim[a,*,1], Hee-Jee Lee[a,1], Ji-Su Kim[a,1], Sung-Ho Kang[b], Eun-Jin Yang[b], Kyoung-Ho Cho[b], Zhexi Tian[a], Anthony Andrady[c]
[a] Department of Marine Science, College of Natural Sciences, Incheon National University, 119 Academy-ro, Yeonsu-gu, Incheon 22012, Republic of Korea
[b] Division of Ocean Sciences, Korea Polar Research Institute, 26 Songdomirae-ro, Yeonsu-gu, Incheon 21990, Republic of Korea
[c] Department of Chemical and Biomolecular Engineering, North Carolina State University, Raleigh, NC 27695, USA

ARTICLE INFO
Editor: Dr. L. Angela Yu-Chen
Keywords:
Microplastics
Western Arctic ocean
Ice-trapping
Seasonal sea ice
Snow
Melt pond water
Mass budget

ABSTRACT
Arctic sea ice entraps microplastics (MP) from seawater and atmosphere and is recognized as sink and transport vector of MPs. However, ice-trapped fraction in the global MP budget, contribution of atmospheric input, and linkage among Arctic basins remain unclear. To assess them, we investigated the number- and mass-based data separated by size and shape geometry for MPs in sea ice, snow, and melt pond water from the western Arctic Ocean (WAO). A significant dependency of MP data on measured cutoff size and geometry was found. For the same size range and geometry, sea ice MPs in WAO ((11.4 ± 9.12) × 10^3 N m^{-3} for ≥ 100 μm) were within comparable levels with those in other Arctic basins, but showed closer similarity in polymer and shape compositions between WAO and Arctic Central Basin, indicating the strong linkage of the two basins by the Transpolar Drift. Our budgeting shows that a significant amount of plastic particles ((3.4 ± 2.6) × 10^{16} N; 280 ± 701 kilotons), which are missed from the global inventory, is trapped in WAO seasonal sea ice, with < 1% snowfall contribution. Our findings highlight that WAO ice zone may play a role as a sink of global MPs as well as

JGR Oceans
RESEARCH ARTICLE
10.1029/2021JC017914

Special Section:
Uncovering the hidden links between dynamics, chemical, biogeochemical and biological processes under the changing Arctic

Seasonal Flux of Ice-Related Organic Matter During Under-Ice Blooms in the Western Arctic Ocean Revealed by Algal Lipid Biomarkers

Jong-Ku Gal[1], Sun-Yong Ha[1], Jisoo Park[1], Kyung-Hoon Shin[2], Dongseon Kim[3], Nan-Young Kim[4], Sung-Ho Kang[1], and Eun Jin Yang[1]
[1]Division of Ocean Sciences, Korea Polar Research Institute, Incheon, Republic of Korea, [2]Department of Marine Science and Convergence Technology, Hanyang University, Ansan, Republic of Korea, [3]Marine Environmental Research Center,

Geophysical Research Letters
RESEARCH LETTER
10.1029/2021GL092714

Role of Intense Arctic Storm in Accelerating Summer Sea Ice Melt: An In Situ Observational Study

Liran Peng[1], Xiangdong Zhang[1], Joo-Hong Kim[2], Kyoung-Ho Cho[2], Baek-Min Kim[3], Zhaomin Wang[4,5], and Han Tang[1]
[1]International Arctic Research Center and Department of Atmospheric Sciences, University of Alaska Fairbanks, Fairbanks, AK, USA, [2]Korea Polar Research Institute, Incheon, South Korea, [3]Department of Environmental Atmospheric Sciences, Pukyong National University, Busan, South Korea, [4]College of Oceanography, Hohai University, Nanjing, China, [5]Southern Marine Science and Engineering Guangdong Laboratory (Zhuhai), Zhuhai, China
Liran Peng and Xiangdong Zhang are cofirst authors.

Key Points:
- An intense storm occurred in summer 2016 and accelerated sea ice melt in the Chukchi Sea
- A net heat energy loss occurred at sea ice surface, not supporting the accelerated sea ice melt rate
- Storm-induced increase in surface ocean mixing and upward heat transport enhanced oceanic heat flux and sea ice bottom melt

Supporting Information:
Supporting Information may be found in the online version of this article.

Abstract Intense storms have been more frequently observed in the Arctic during recent years, in coincidence with extreme sea ice loss events. However, it is still not fully understood how storms drive such events due to deficient observations and modeling discrepancies. Here we address this problem by analyzing in situ observations acquired during an Arctic expedition, which uniquely captured an intense storm in summer 2016. The result shows a pronounced acceleration of sea ice loss during the storm process. Diagnostic analysis indicates a net energy loss at the ice surface, not supporting the accelerated melting. Although the open water surface gained net heat energy, it was insufficient to increase the mixed-layer temperature to the observed values. Dynamic analysis suggests that storm-driven increase in ocean

JGR Oceans
RESEARCH ARTICLE
10.1029/2020JC017063

Special Section:
Uncovering the hidden links between dynamics, chemical, biogeochemical and biological processes under the changing Arctic

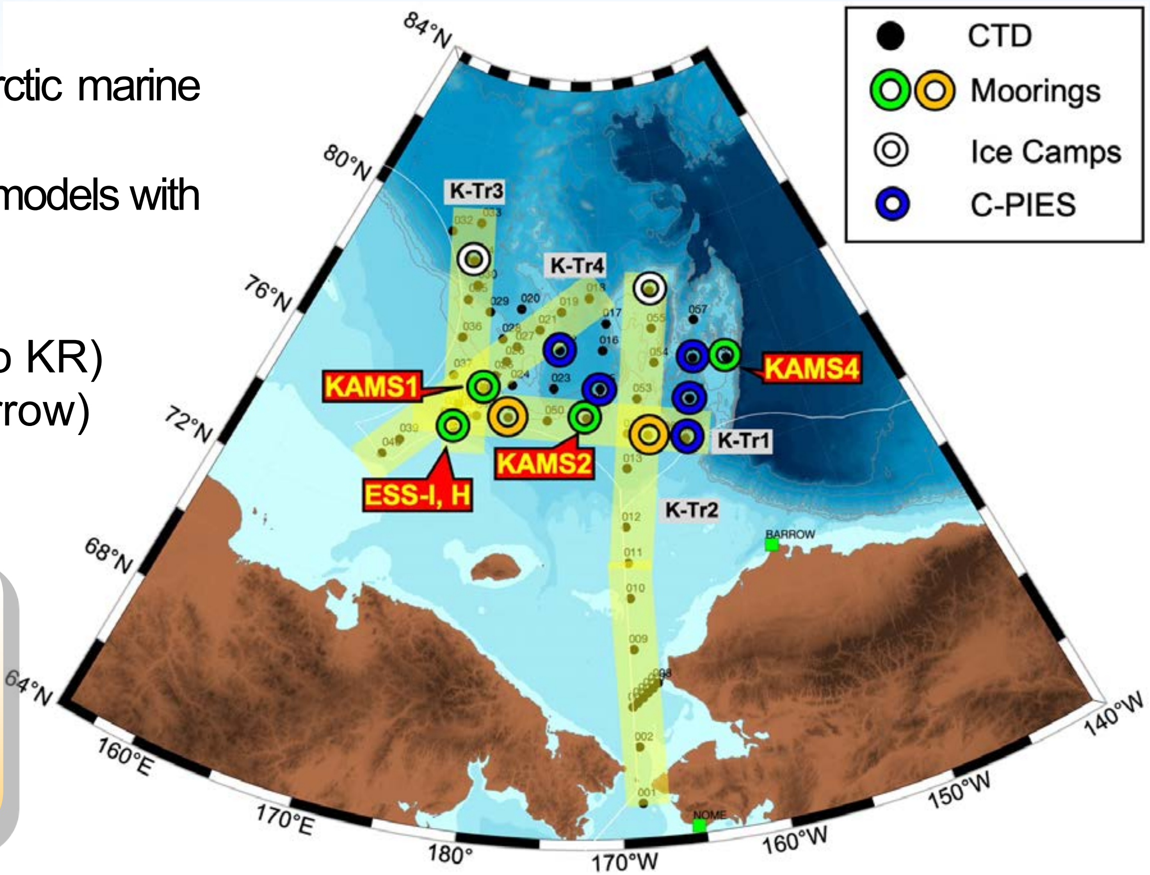
Trophic Dynamics of *Calanus hyperboreus* in the Pacific Arctic Ocean

Hyuntae Choi[1], Haemin Won[1], Jee-Hoon Kim[2], Eun Jin Yang[2], Kyoung-Ho Cho[2], Youngju Lee[2], Sung-Ho Kang[2], and Kyung-Hoon Shin[1]
[1]Department of Marine Sciences and Convergent Technology, Hanyang University, Ansan, South Korea, [2]Division of Ocean Sciences, Korea Polar Research Institute (KOPRI), Incheon, South Korea

- Ocean-Sea Ice-Atmosphere Integrated Observations (Bering strait, Chukchi/East Siberian Seas of Pacific CAO)
  - Korea-Arctic Ocean WArming & Response of Ecosystem (K-AWARE) (from 2021 to 2026)

- Aims of the cruise:
  - To establish a monitoring system for analyzing variations in the Arctic marine environment caused by the Arctic warming
  - To project future changes in the Arctic environment using numerical models with observational data

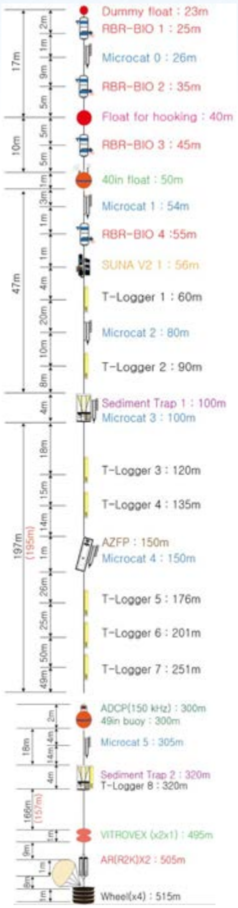
- Whole Period: 2022.07.04 - 10.04 (1st, 2nd, and 3rd Legs; KR to KR)
- 2nd Leg Period : 2022.07.19 - 08.21 (from Dutch Harbor to Barrow)
- Chief Scientist of 2nd Leg: Eun-Jin Yang (ejyang@kopri.re.kr)



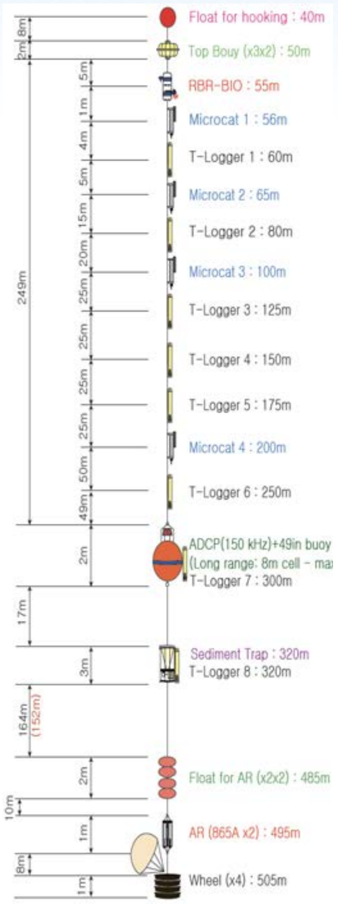
CTD/XCTD: ~60 stations
Ocean Mooring: 4 sets + additional 1~2
C-PIES: 3 (recovery only) + 5 (new deployment)
Sea ice camp: 1~2 sites

Korea Arctic Mooring System

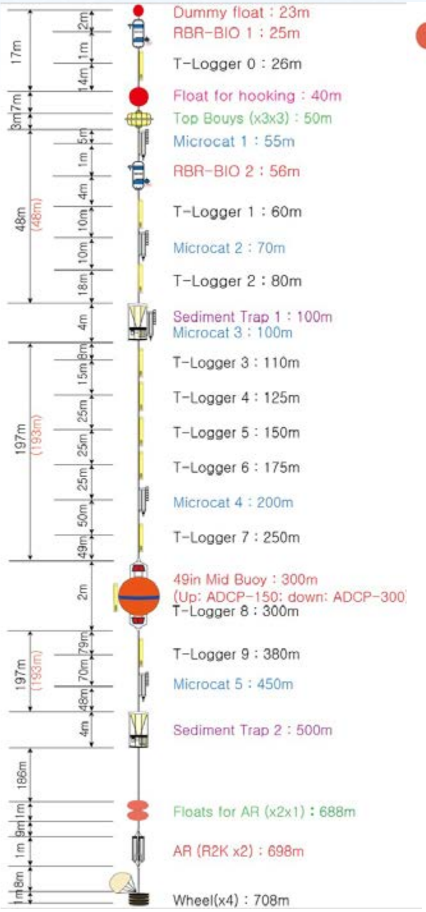
KAMS1-22



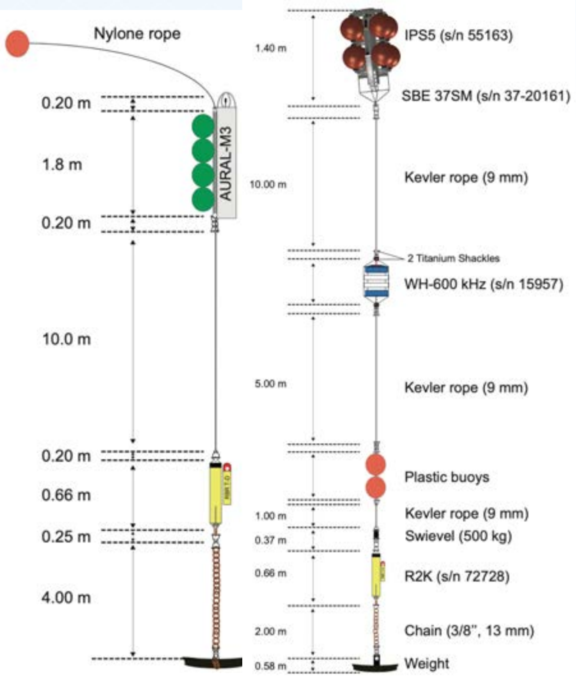
KAMS2-22



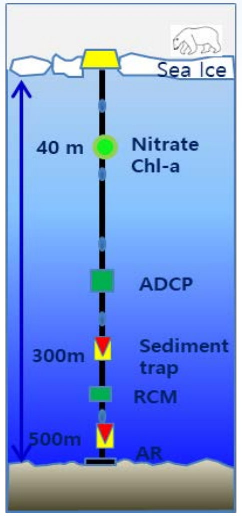
KAMS4-22

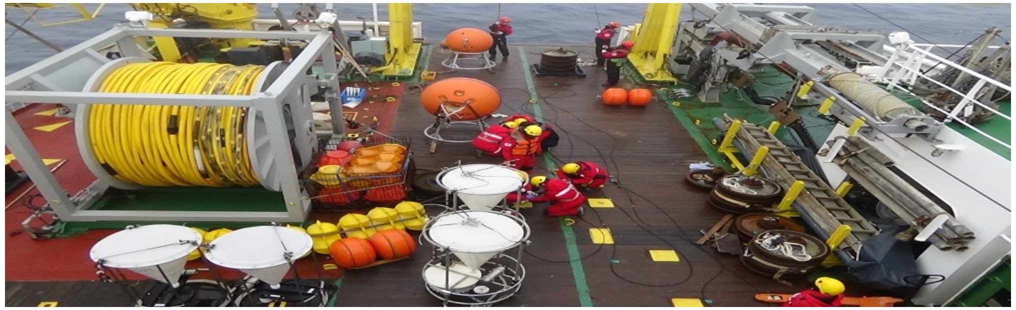


ESS-H&I-22



New Sed. Trap mooring





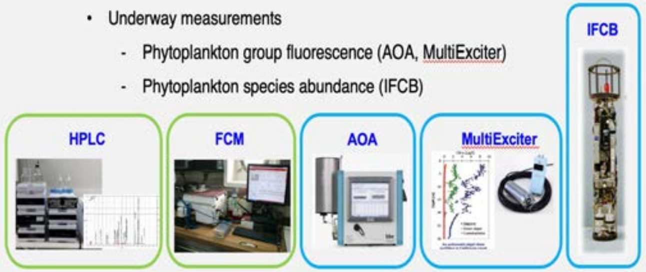
KOPRI KIMST 해양수산부

SAS-Korea Activity Plan in 2022

Phytoplankton community (Imaging FlowCytobot)

❑ *Spatio-temporal distribution of phytoplankton groups*

- Discrete samples
  - Phytoplankton species abundance (Microscope)
  - Total and size-fraction chl-a concentrations (Trilogy)
  - Phytoplankton group biomass (HPLC)
  - Picophytoplankton abundance (FCM)
- Underway measurements
  - Phytoplankton group fluorescence (AOA, MultiExciter)
  - Phytoplankton species abundance (IFCB)



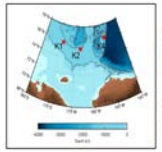
Phytoplankton physiology

❑ Photophysiological properties of phytoplankton in the Chukchi Sea

- Plan to use the Fluorescence Induction and Relaxation system (FIRe), which was based on active fluorometry
- Continuous underway measurement + discrete sampling by depth in stations
- Measurement of photochemical efficiency (F_v/F_m), functional absorption cross-section (σ_{PSII}) and maximum electron transfer rate (ETR^{max})
- Future studies on interannual variability of phytoplankton photophysiology are planned

❑ Seasonal variation of phytoplankton in the northern Chukchi Sea

- Data logger + CHL & PAR sensor were recovered and re-moored at three mooring sites every year (K1, K2, & K4 stations)
- In the K1 station, sensors were installed at 25 m, 35 m, 55 m, and 65 m
- In the K2 & K4 station, sensors were installed at 25 m and 55 m
- Plan to study timing of under-ice blooms using this



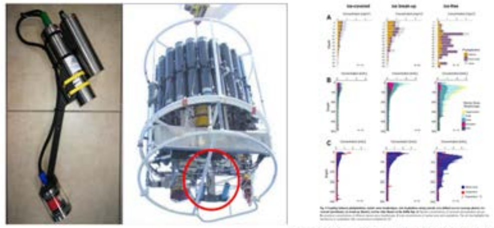
Mesozooplankton community

❑ Study on the Interannual Patterns of Summer zooplankton & Benthos Community Structures

- Collection of zooplankton of various sizes (150, 330, 500 µm mesh nets), and establishment of vertical collection method
- Identification of benthic fauna, identification of food web communities
- Comparing environmental DNA (eDNA) and species collection for Arctic metazoan biodiversity
  - ✓ Metabarcoding of COI mitochondrial and 18S rRNA genes from environmental samples

Vertical distribution of zooplankton (Underwater Vision Profiler)

❑ Study on the vertical distribution of zooplankton based on the optical observation in the western Arctic Ocean



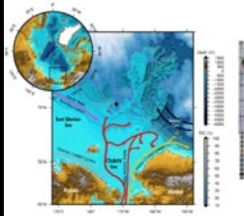
Vertical profiles of particles (Trudnowska et al., 2021)

- High resolution approach to understand the specific vertical profiles of zooplankton community
- Application of UVP6 (Underwater Vision Profiler 6) during the Arctic cruise
  - ✓ Image analyzer that targets >100 µm marine materials (plankton and large particles, etc.)
  - ✓ It is mounted on the CTD frame.
  - ✓ Sorting through EcoTaxa platform (PIQv, Open source)
- Establishment of further evidence for vertical migration of zooplankton in the Arctic Ocean

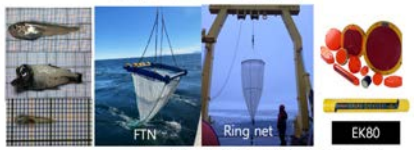
Zooplankton acoustics (Broadband acoustics, WBAT)

❑ The vertical distribution of Key copepod species and fish in the western Arctic Ocean

- Verify the differences in the vertical dynamics of *C. hyperboreus*, *C. glacialis*, *M. longa* related to food and environmental conditions
- Acoustic, biological, and oceanographic data are collected at each station.

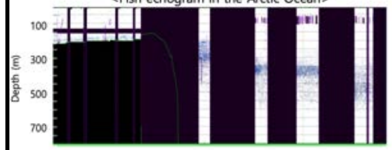


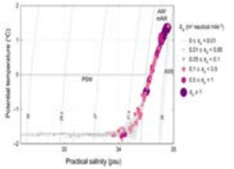
<Zooplankton and Fish sampling>



<Acoustic data within water masses>

<Fish echogram in the Arctic Ocean>



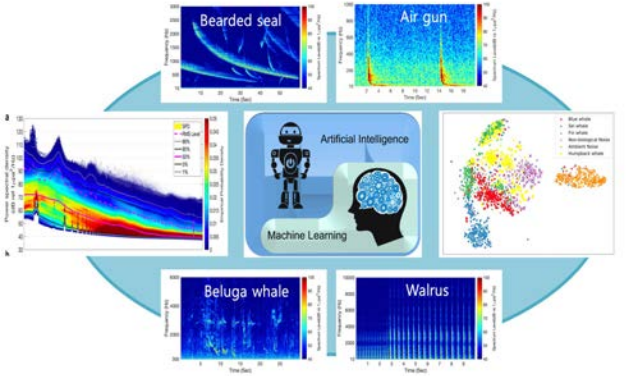


Snoeijs-Leijonmalm et al. (2022)

Soundscape in the ESS

❑ The soundscape in the rapidly changing Arctic

- Record and monitor seasonal variation of the soundscape in the NESS.
- Identify anthrophony (air gun), biophony (whales and seals), and geophony (wind and sea ice) sounds.



북극해 온난화-해양생태계 변화 감시 및 미래전망 연구

KOPRI KIMST 해양수산부

SAS-Korea Activity Plan in 2022

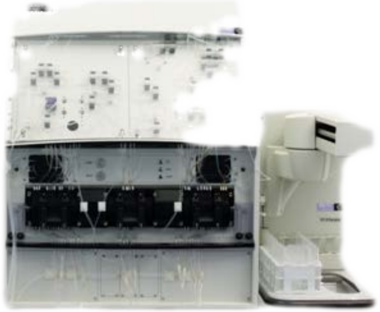
- **Continuous observation of *p*CO_2 in the surface**
- **Measurement of dissolved inorganic carbon (DIC)**
- **Net community production (NCP) using an equilibrator-inlet mass spectrometry (EIMS)**


Continuous observation system of *p*CO_2 (underway)

EIMS used for the underwa y measurements of $\Delta O_2/Ar$-NCP

Continuous observation sy stem (MMIS)

- **Observations of nutrients (NH_4, NO_2+NO_3, PO_4 and SiO_2)**
- **Measurement of dissolved and particulate organic matters (DOM and POM)**
- **Estimates of river run-off and ice melt water**
- **Estimates of sinking particle flux**



Seawater auto analyzer

TOC-TN analyzer

CHN analyzer

DOC sampler

Sediment trap

Data availability via the Korea Arctic Ocean-data System (KAOS)

KAOS [http://kaos.kopri.re.kr]

Thank you for your attention!