Korean Arctic Ocean Research Plan in 2018
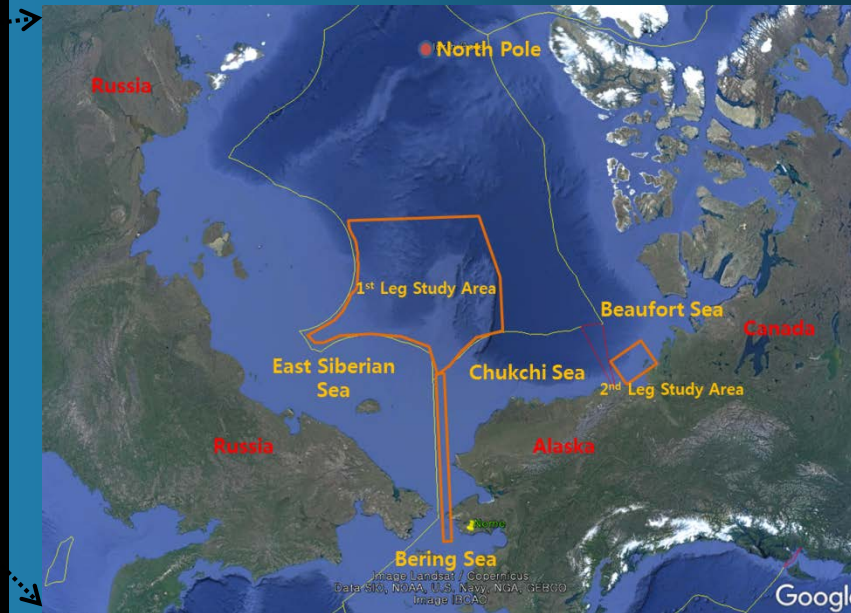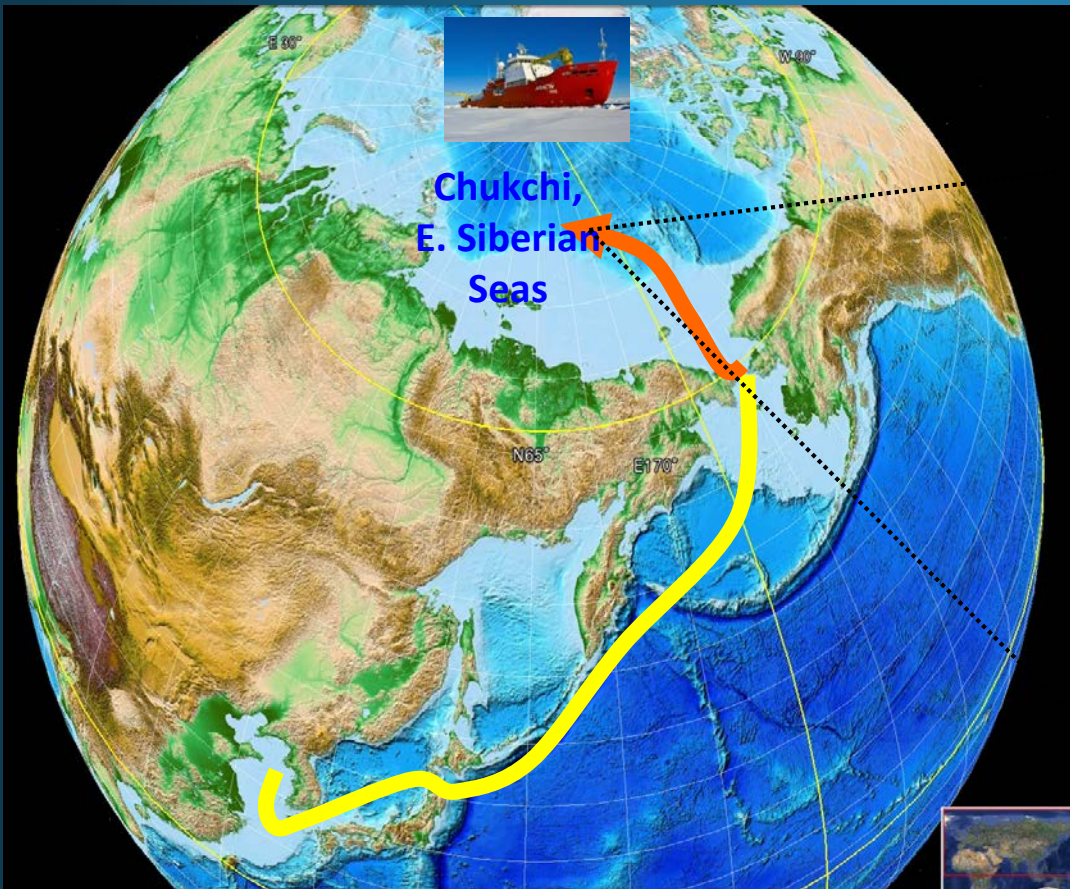
Sung-Ho Kang & Eun-Jin Yang

Korea Polar Research Institute (KOPRI), Incheon, Korea

Pacific Arctic Group Meeting, Davos
June 18, 2018

http://pag.arcticportal.org/

KOPRI
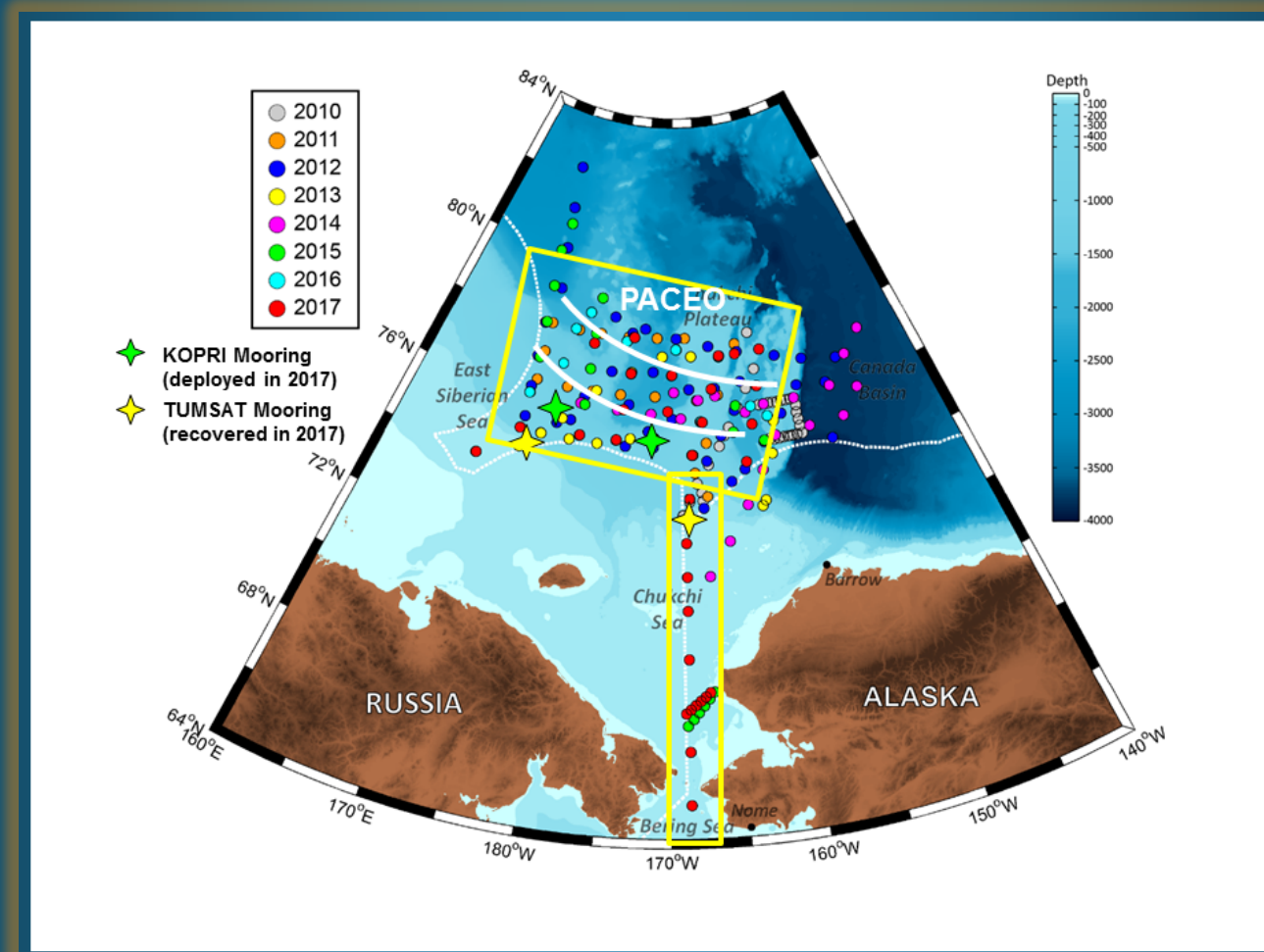Korea Polar Research Institute

Korean Arctic Ocean Expedition

2018 expedition periods: from 21, July to 29, September
(Incheon-Nome-Barrow-Busan)
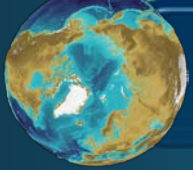
IB R/V ARAON Arctic Survey (2010~2017)

	2010	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**
CTD	38	18	44	16	32	42	34	35
XCTD	*	33	48	36	51	61	38	30
Period	07/20~08/10	08/02~08/16	08/04~09/06	08/24~09/01	08/01~08/23	08/01-08/21	08/05-08/21	08/06-08/24

2018 KOPRI Arctic Research activity

First Leg: 2018. 8. 4 ~ 8. 25

Second Leg: 2018. 8.29 ~ 9.17

2018 KOPRI Arctic Expedition (1ˢᵗ leg)

- **Ocean-Sea Ice-Atmosphere Integrated Observations (Chukchi/East Siberian Seas of Pacific CAO)**

  - Korea Arctic Ocean Observing System (K-AOOS)

  - Research on analytical technique for satellite observation of Arctic Sea ice

- **Aims of the cruise:**

  - To identify key environmental parameters (physical and biogeochemcial) in rapid transition due to the sea-ice decrease in the Pacific Central Arctic Ocean (CAO) and predict environmental change patterns.

  - To development of satellite-based sea ice change observation system
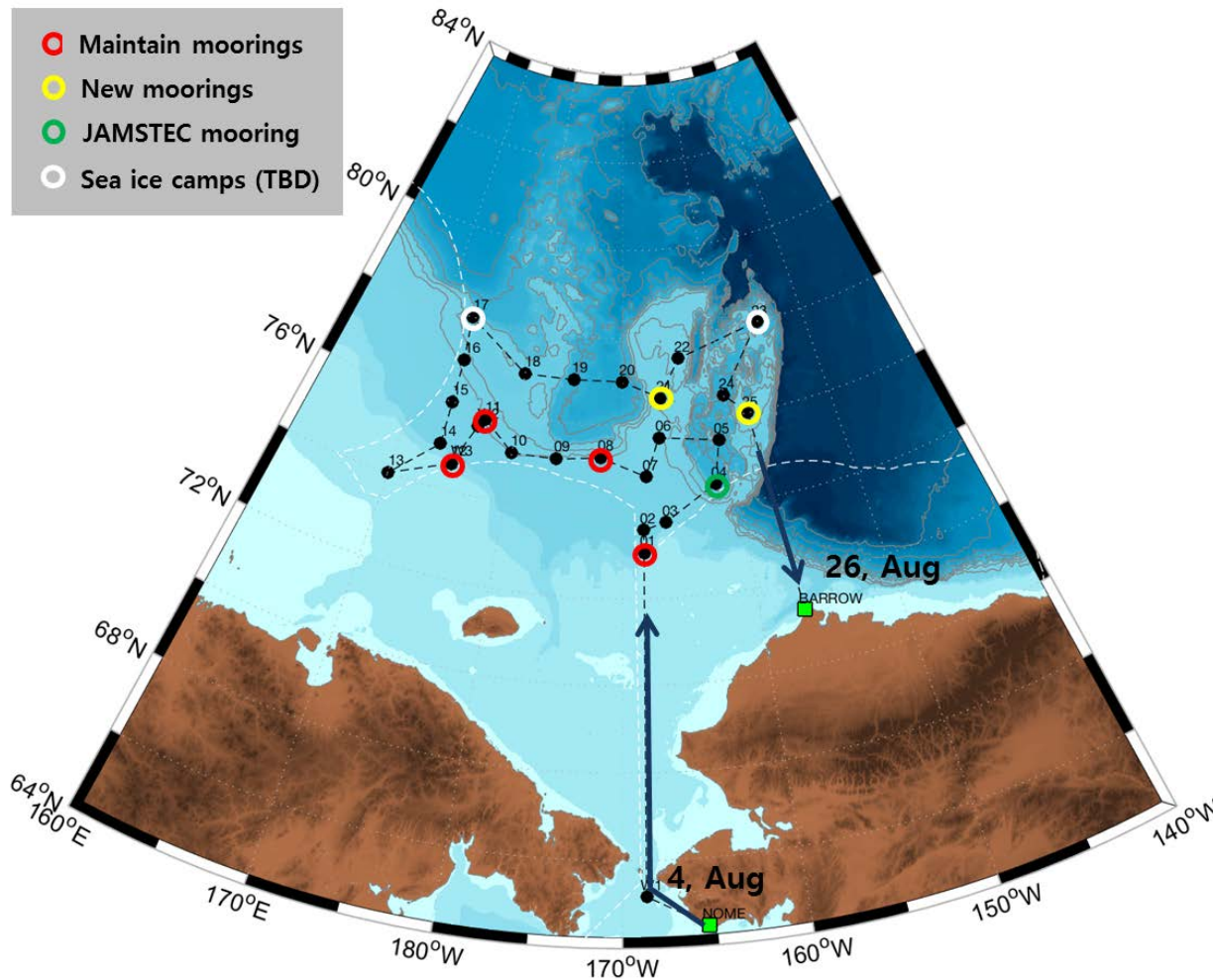
- **Period: 2018. 8.4 - 8.24 (from Nome to Barrow)**

- **Chief Scientists: Sung-Ho Kang (shkang@kopri.re.kr)**

- **Participating nations: Korea, Croatia, Japan, Norway, Russia, th UK, theUSA**

2018 Arctic Ocean Expedition

# 1st Leg (ocean-sea ice-atmosphere)


2018 Arctic Ocean Expedition Plan (ARA09B)

- ➢ **Chukchi shelf**
- ➢ **Chukchi Borderland to East Siberian Sea**
- ➢ **2 Sea Ice stations**
- ➢ **Ocean mooring station (6 stations)**

Atmospheric Observations

🔴 **Surface and upper-air meteorological variables**: understanding and prediction of weather events

🔴 **Radiative fluxes and clouds**: clouds' role in radiation budget, cloud amount & vertical distribution
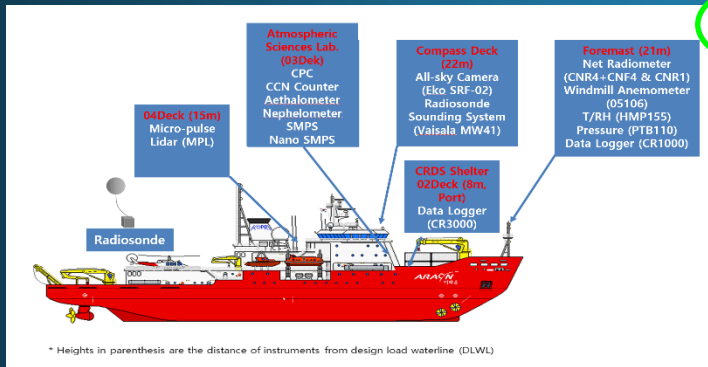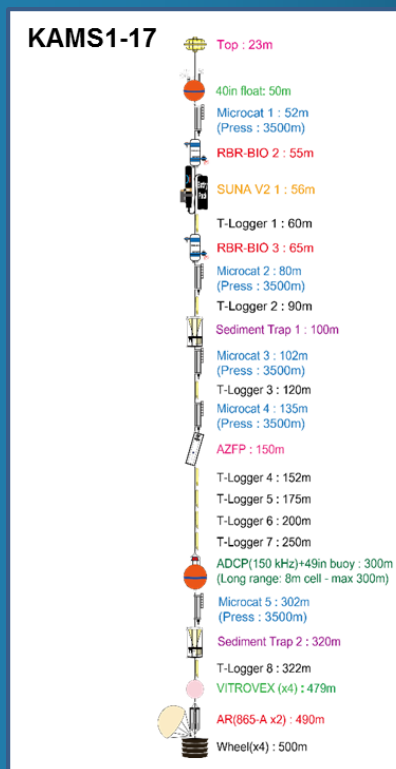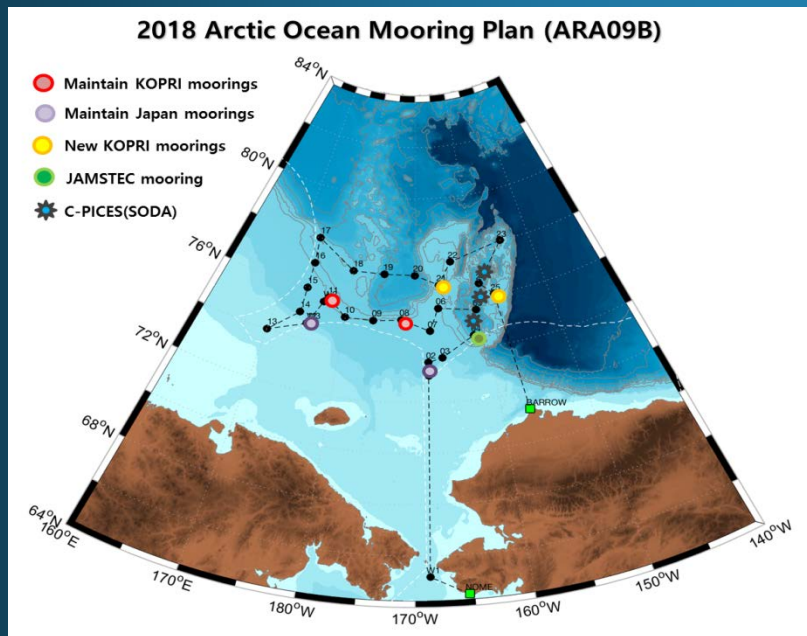

🔴 **Aerosols and gases**: Black carbon (BC), ozone, cloud condensation nuclei (CCN), PM10, etc.


Incheon-Nome-Barrow-Busan
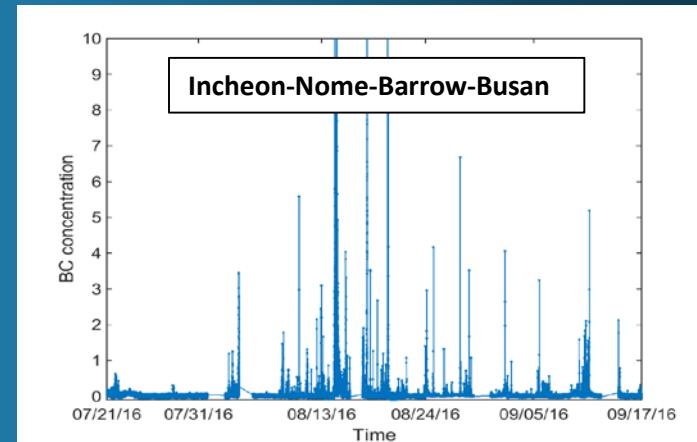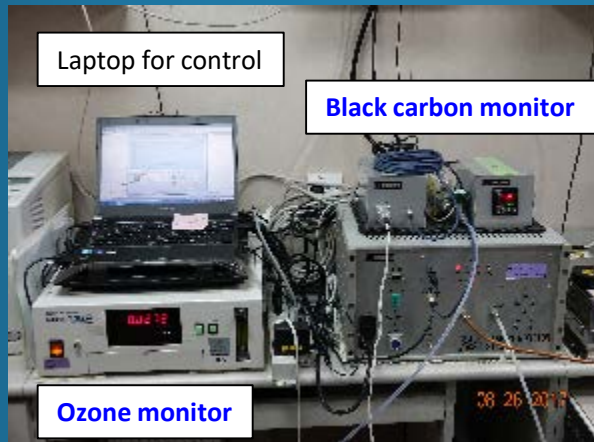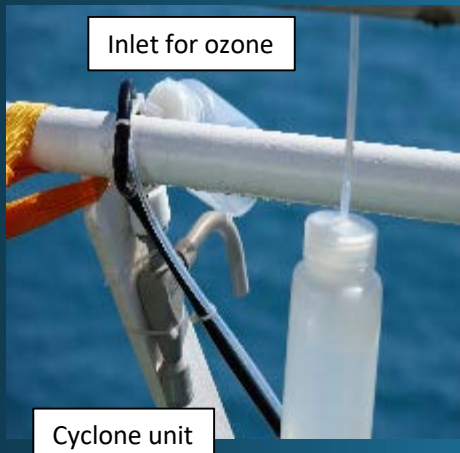
Preliminary result

Physical Oceanography

- **Objective: to identify the variation of water mass distribution and structure**
- **Equipment: CTD, XCTD, Lowered ADCP, ocean mooring system**
- **Ocean mooring system: ADCP, microCAT , temperature logger, sediment trap, AZFP, nitrate sensor (SUNA V2), Fluorescence & PAR sensors**

2018 Arctic Ocean Mooring Plan (ARA09B)

- 🔴 Maintain KOPRI moorings
- 🟣 Maintain Japan moorings
- 🟡 New KOPRI moorings
- 🟢 JAMSTEC mooring
- ✴ C-PICES(SODA)

KAMS1-17

- Top : 23m
- 40in float : 50m
- Microcat 1 : 52m (Press : 3500m)
- RBR-BIO 2 : 55m
- SUNA V2 1 : 56m
- T-Logger 1 : 60m
- RBR-BIO 3 : 65m
- Microcat 2 : 80m (Press : 3500m)
- T-Logger 2 : 90m
- Sediment Trap 1 : 100m
- Microcat 3 : 102m (Press : 3500m)
- T-Logger 3 : 120m
- Microcat 4 : 135m (Press : 3500m)
- AZFP : 150m
- T-Logger 4 : 152m
- T-Logger 5 : 175m
- T-Logger 6 : 200m
- T-Logger 7 : 250m
- ADCP(150 kHz)+49in buoy : 300m (Long range: 8m cell - max 300m)
- Microcat 5 : 302m (Press : 3500m)
- Sediment Trap 2 : 320m
- T-Logger 8 : 322m
- VITROVEX (x4) : 479m
- AR(865-A x2) : 490m
- Wheel(x4) : 500m

KAMS2-17

- Top : 20m
- Plastic Bouy (x4) : 50m
- Microcat 1 : 51m (Press : 2000m)
- RBR-BIO 1 : 55m
- SUNA V2 1 : 56m
- T-Logger 1 : 58m
- Microcat 2 : 65m (Press : 2000m)
- T-Logger 2 : 80m
- Microcat 3 : 100m (Press : 2000m)
- T-Logger 3 : 120m
- T-Logger 4 : 140m
- Microcat 4 : 150m (Press : 2000m)
- T-Logger 5 : 175m
- T-Logger 6 : 200m
- T-Logger 7 : 250m
- ADCP(150 kHz)+49in buoy : 300m (Long range: 8m cell - max 300m)
- Microcat 5 : 302m (Press : 2000m)
- Sediment Trap : 320m
- T-Logger 8 : 322m
- T-Logger 9 : 350m
- Syntactic foam float (x2), VITROVEX (x2) : 478
- AR(865-A x2) : 490m
- Wheel(x4) : 500m

Chemical Oceanography

🔴 **Pursuing spatial and temporal variation of pCO_2 system in the Arctic Ocean**

🔴 **Net community production(NCP) using EIMS(Equilibrator-inlet Mass Spectrometry)**
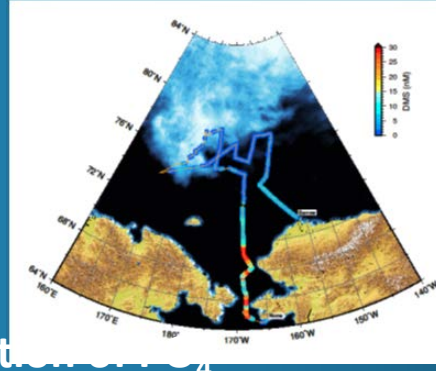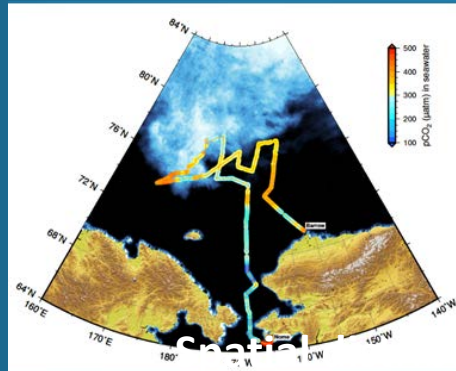
Continuous observation system of pCO_2

Dissolved pCO_2 along the track

Dissolved O2/Ar along the track

Continuous observation system(MMIS) of NCP and DMS

🔴 **Behavior of nutrients (NH_4, NO_2+NO_3, PO_4 and SiO_2)**

🔴 **Characteristics of dissolved and particulate organic matters (DOM and POM)**

🔴 **UV-absorbing compounds (Mycosporine-like amino acids)**
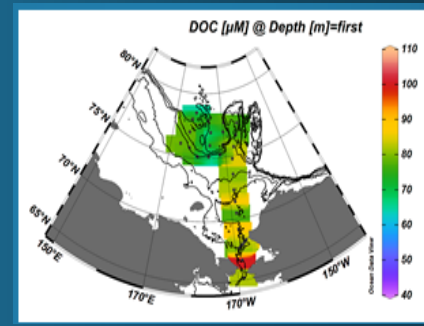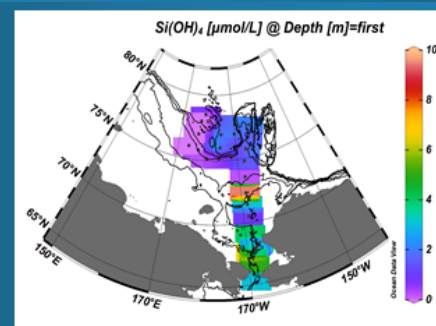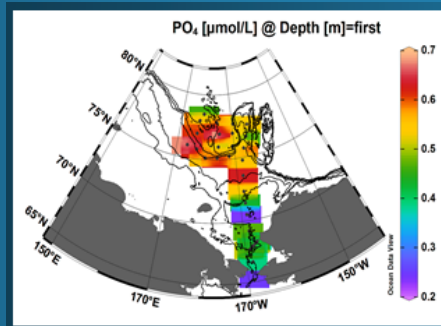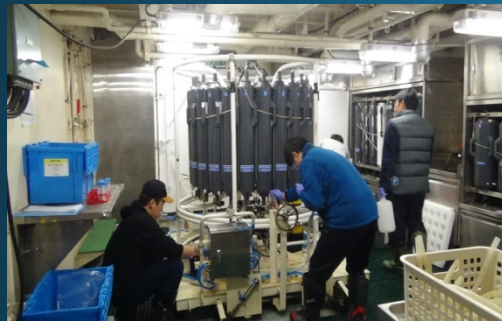
Spatial distribution of PO_4

Spatial distribution of $Si(OH)_4$

Spatial distribution of DOC

Microplastics (MPs)

- To investigate **abundance, fate, and distribution of microplastics** in Arctic region
- To get basic data to predict **the effect of MPs on Arctic ecosystem and sea-ice melting/formation**
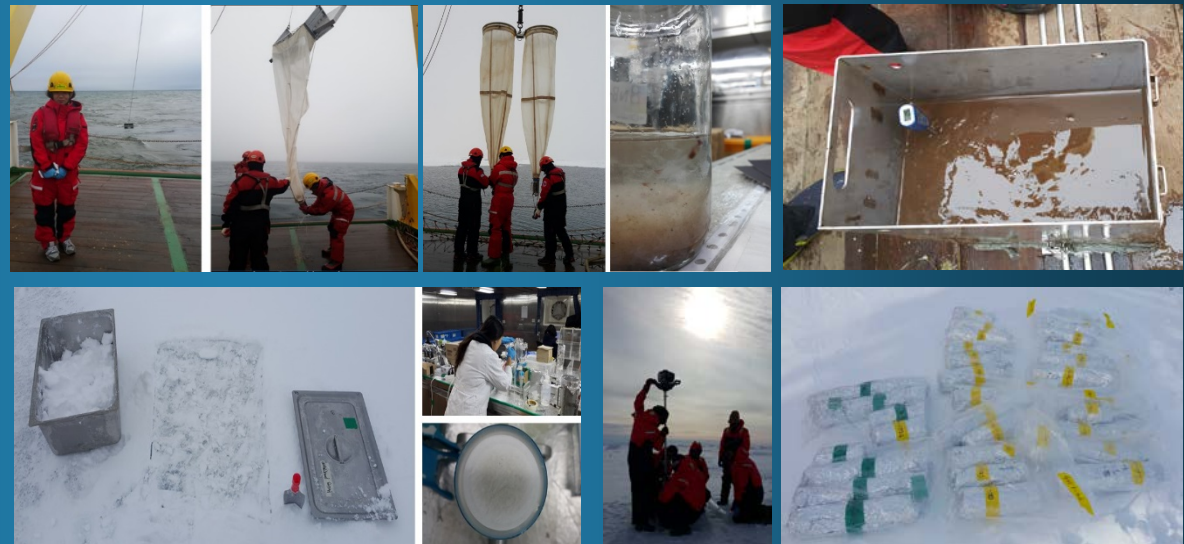
Analytical components;
- Microplastics
- TEP & CSP

Sample Collection;
- Surface water (MTN), subsurface water (BN), sediment (Box corer), snow, sea ice, and air for MPs
- Seawater (Surface/SCMD/bottom layer) for TEP
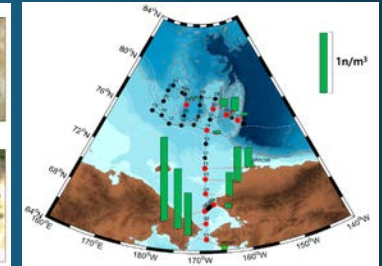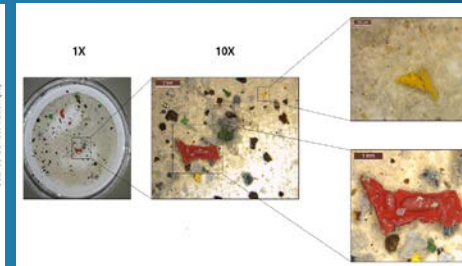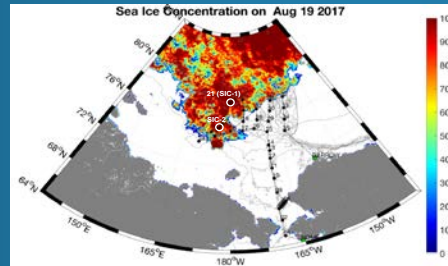
▲ Filtration systems for collecting TEP/CSP

▲ Sampling for MPs (MTN for surface water, BN for subsurface water, Box corer for sediment, Snow & sea-ice sample at ICE-camp

Biological Oceanography

- **Distribution of bacteria and virus and community structure**
- **Species compositions of phytoplankton**
- **Abundance and community structure of heterotrophic protists**
- **Mesozooplankton community and grazing impacts on phytoplankton biomass**
- **Primary production, new production, and photosynthetic pigments**
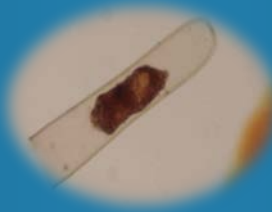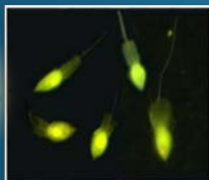- **Food web interaction between phytoplankton and zooplankton**
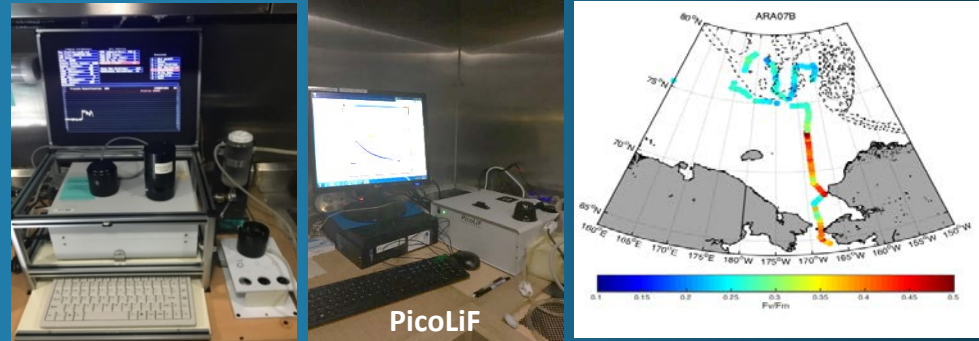

Phytoplankton Net

Zooplankton Net

Deck Incubation

Collecting the seawater

Biological Oceanography

Phytoplankton physiology

- To understand the **photosynthetic characteristics** of phytoplankton
  - -> Photochemical efficiency (FIRe II)
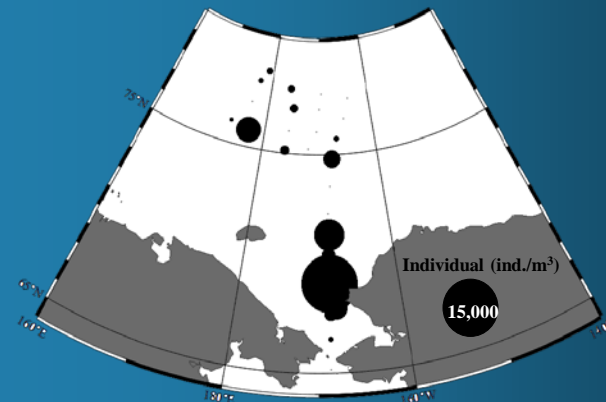 - -> Quantum yield of fluorescence (PicoLiF)

PicoLiF

Zooplankton acoustic survey

- **Vertical variation of sound-scattering layers** with multi-frequency scientific echosounder (EK60)
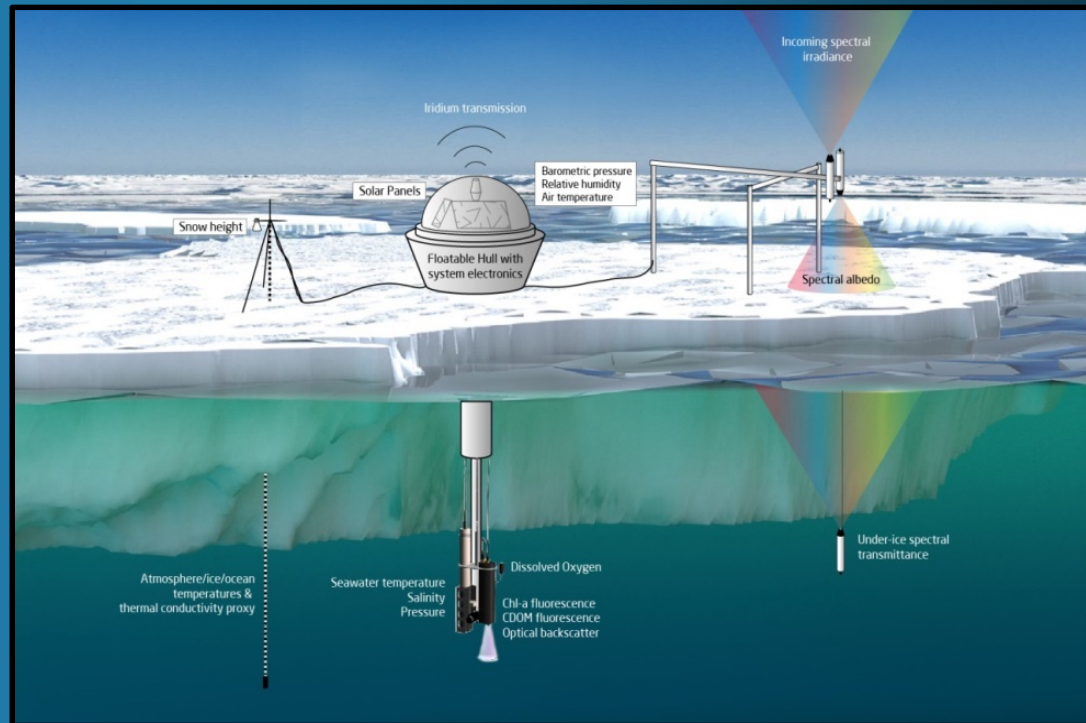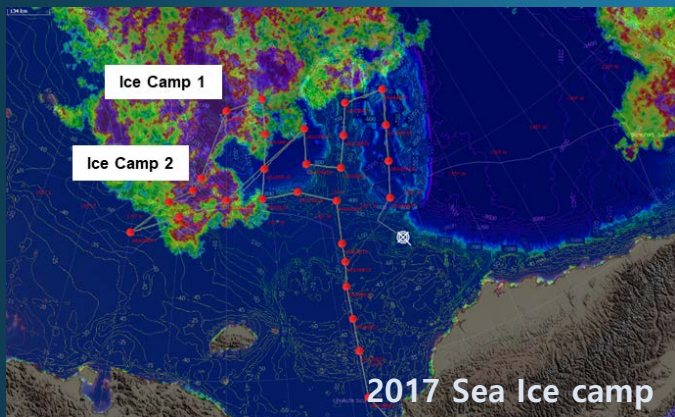- **Horizontal variation of copepods abundance** estimated by acoustic backscatter data

38 kHz

120 kHz

200 kHz
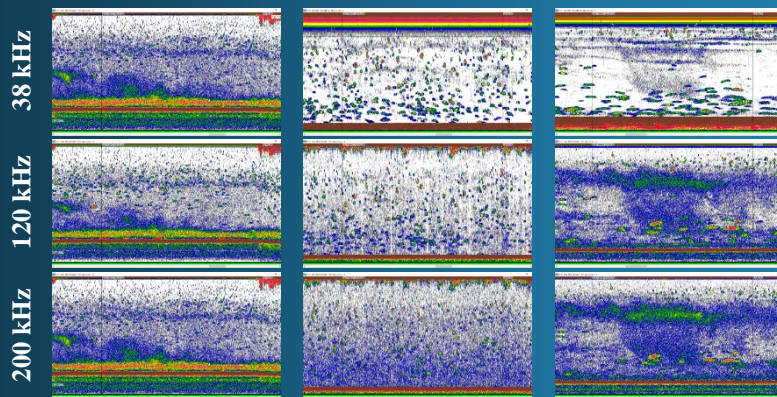
[Vertical variation of acoustic backscatter]

Individual (ind./m³)

15,000

[Horizontal variation of copepods abundance]

Sea ice bio-physics

🔴 **Buoy deployments and in-situ measurements for bio-physical observation**

- **To measure** in-situ bio-physical parameters of atmosphere-snow-sea ice- underwater sea ice

- **To study the** air-ice-ocean interaction, ice deformation, melt pond energy budget

🔴 **International collaboration: KOPRI, BAS(UK), AWI(Germany)**

Ice Camp 1

Ice Camp 2

2017 Sea Ice camp

In-situ melt pond observation (KOPRI)

Melt pond Ice Mass Balance
with radiation sensors (KOPRI & BAS)

Incoming spectral irradiance

Iridium transmission

Snow height

Solar Panels

Barometric pressure
Relative humidity
Air temperature

Floatable Hull with
system electronics

Spectral albedo

Atmosphere/ice/ocean
temperatures &
thermal conductivity proxy

Seawater temperature
Salinity
Pressure

Dissolved Oxygen

Chl-a fluorescence
CDOM fluorescence
Optical backscatter

Under-ice spectral
transmittance

(By Eco-Light program)

Melt Pond Study

🔴 To define **environmental characteristics of various melt ponds** on sea ice floes in the Arctic Ocean

🔴 To understand **food web interaction associated with melt pond condition and ice core**

🔴 To estimate the **carbon contribution of entire sea ice floes** in the Pacific Arctic Ocean.
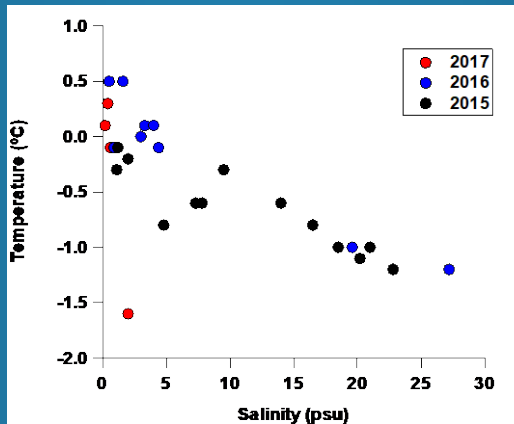
Melt pond study site from 2017 (Ice camp 1)

Temperature & Salinity

Melting pond study (Ice camp 2)

🔴 **Research components;**

- Plankton composition, diversity and physiology
- Gas interaction between air and surface of ponds
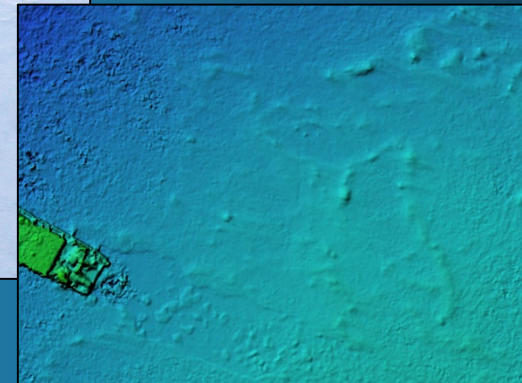- Biochemical parameters (Carbon and Nitrogen …)

Ice core sampling

Remote Sensing of Arctic Ocean and Sea Ice

Research items;
- Apparent optical properties of Arctic ocean
- Inherent optical properties of Arctic ocean
- Satellite/helicopter-borne /UAV remote sensing
- Sea ice and melt pond observation

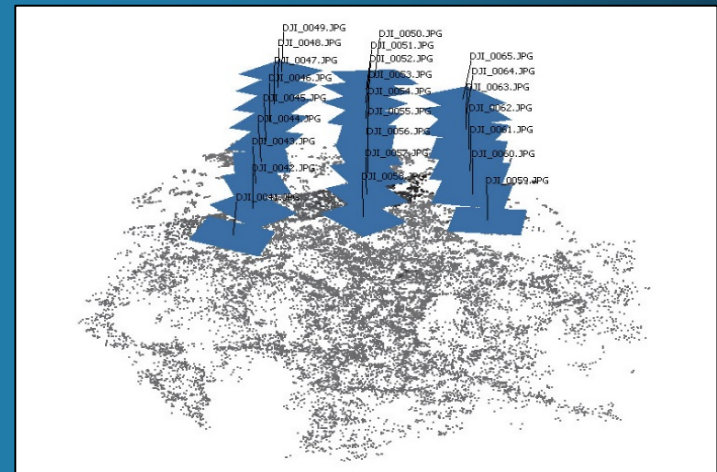# Remote Sensing of Arctic Ocean and Sea Ice

Deployment of optical profiler

Above-water ocean color measurement

UAV (unmanned aerial vehicle) observation over sea ice

UAV image acquisition strategy

Sea-Ice Prediction modelling

To develop the seasonal prediction system of Arctic sea ice (concentration & depth)

Statistical prediction model:
- The sea ice concentrations over the Arctic domain (>65N) in 1 degree, monthly resolution are being produced operationally.
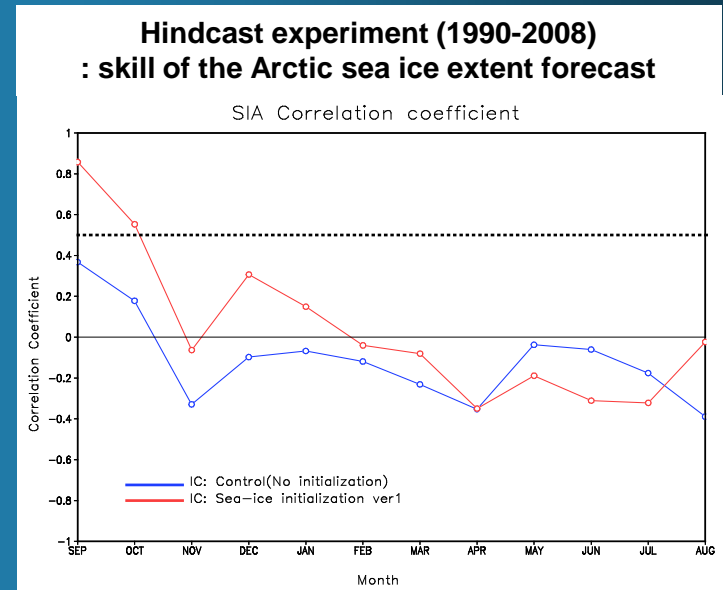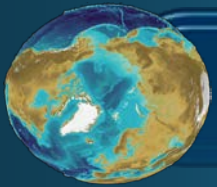
Dynamical prediction model:
- Offline CSIM forced with atmospheric/oceanic forcing are under development.
- The initialization (nudging) method of sea ice of different categories is developed.
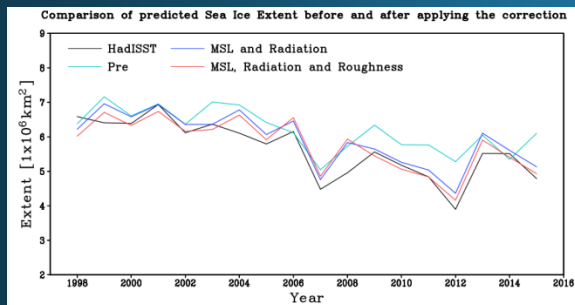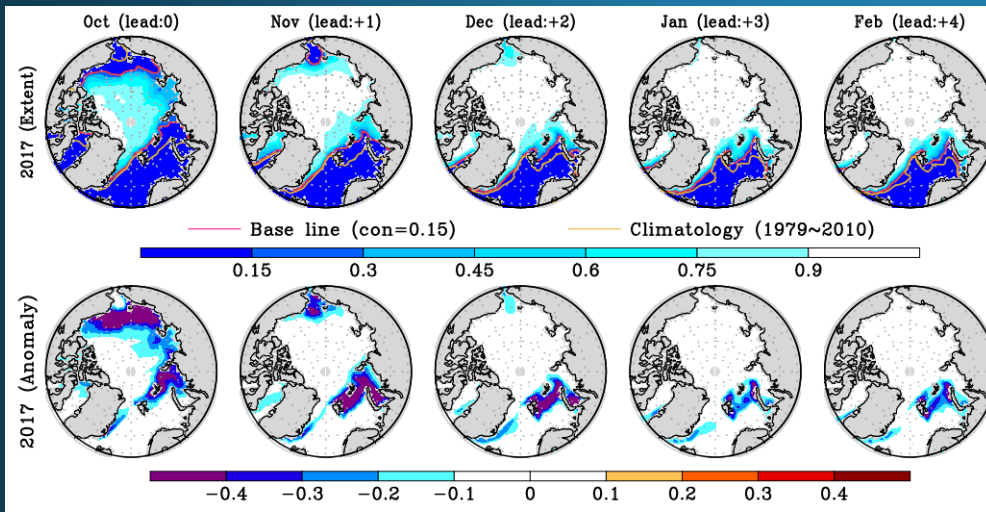
(up) Oct 2017 – Feb 2017 SIC forecasted

(down) September Arctic sea ice extent predicted at July

Hindcast experiment (1990-2008)
: skill of the Arctic sea ice extent forecast

2018 KOPRI Arctic Expedition (2nd Leg)

- **Marine geology/bio-geophysics (East Siberian Sea and Chukchi Sea)**

- **Aims of the cruise:**

  - **To map geological features/structures in the Arctic continental margin**

  - **To understand geological processes related to melting subsea permafrost and gas hydrate in the Arctic**

  - **To evaluate the interactions and linkages in terms of methane cycle in the Arctic**

- **Period: 2018. 8.29 - 9.17 (from Barrow to Nome)**

- **Number of participants: 51**

- **Chief Scientists: Dr. Young-Keun Jin (ykjin@kopri.re.kr)**

- **Participating nations: Korea, Japan, Russia**

2018 Arctic Expedition (2nd Leg)

Study Area: East Siberian Sea & Chukchi Sea

Aug 31-Sept 17

Leg-2

Aug. 29
@ Barrow

Sept. 20
@ Nome
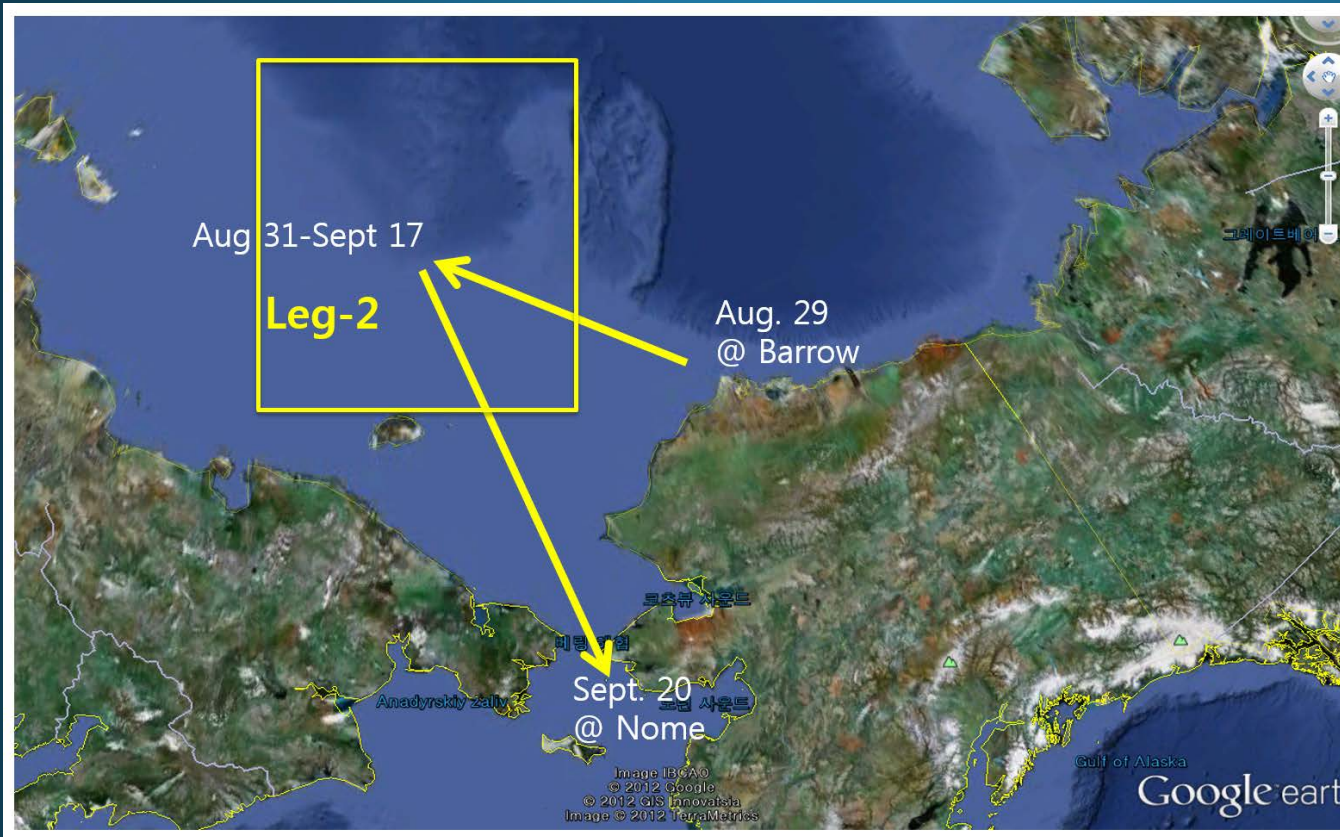
Research items;
- Seismic survey
- Sub-bottom profiling
- bathymetric mapping
- Sediment coring
- Heat flow measurements
- Water column study
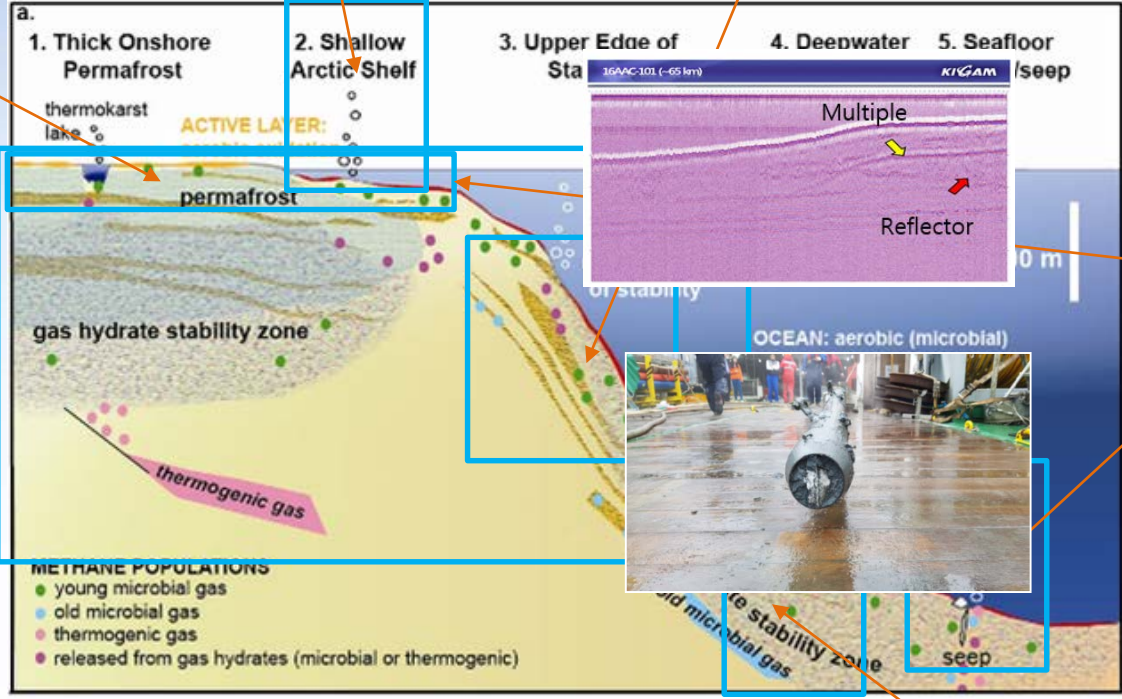- Methane flux study
- Microbiological study

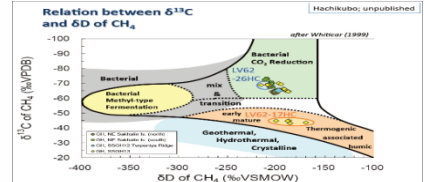# 2018 Arctic Expedition diagram (2ⁿᵈ Leg)

methane concentration/methane cycle

pore water & gas chemistry
Lab study of gas hydrate
Mineral & clay analysis
Heat flow measurement

Mapping of bathymetry/ Methane release structures

Geophysical mapping
Paleo-environment
Marine Geology

biomarker study for methane generation/ consumption processes microbiological study /organic chemistry

mapping of gas hydrate distribution & stability

a.
1. Thick Onshore Permafrost
2. Shallow Arctic Shelf
3. Upper Edge of Sta...
4. Deepwater
5. Seafloor /seep

thermokarst lake
ACTIVE LAYER:
permafrost

Multiple
Reflector
16AAC-101 (~65 km)   KIGAM

gas hydrate stability zone

thermogenic gas

OCEAN: aerobic (microbial)

METHANE POPULATIONS
• young microbial gas
• old microbial gas
• thermogenic gas
• released from gas hydrates (microbial or thermogenic)

seep

Ruppel, Nature Knowledge, Hydrates/Climate, April 2011

Bacterial community

Archaeal community

Relation between δ¹³C and δD of CH₄

Thank you