2019 Korean Arctic Ocean Research Activity

Eun-Jin Yang

Korea Polar Research Institute (KOPRI), Incheon, Korea

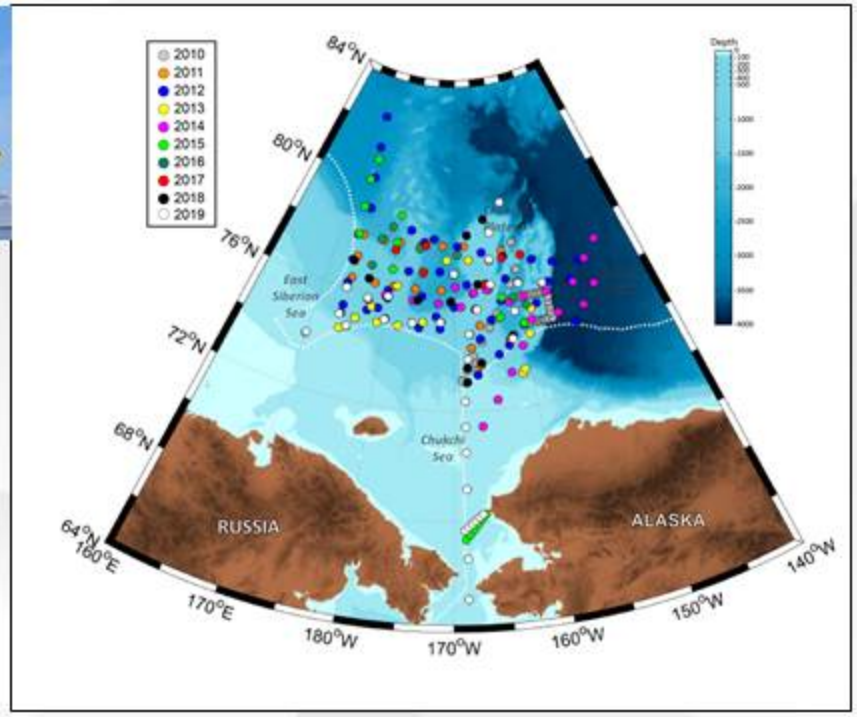
Pacific Arctic Group Meeting, Hangzhou, China
October 14-16, 2019

KOPRI
Korea Polar Research Institute

http://pag.arcticportal.org/

IB R/V ARAON Arctic Survey (2010~2019)

Long-term Observation Hot spot of Sea Ice Loss, Warming Atmosphere, and Changing Ecosystems in Pacific Arctic Region



We are collaborating closely with our partners in Pacific Arctic Group (PAG) to find synergies and joint activities to avoid overlapping efforts.

	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
CTD	38	18	44	16	32	42	34	35	25	34
XCTD	*	33	48	36	51	61	38	30	30	20
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	08/04-08/25	08/03-08/26


2019 KOPRI Arctic Research activity
First Leg: 2019. 8. 3 ~ 8. 26
Second Leg: 2019. 8.29 ~ 9.20
KOPRI

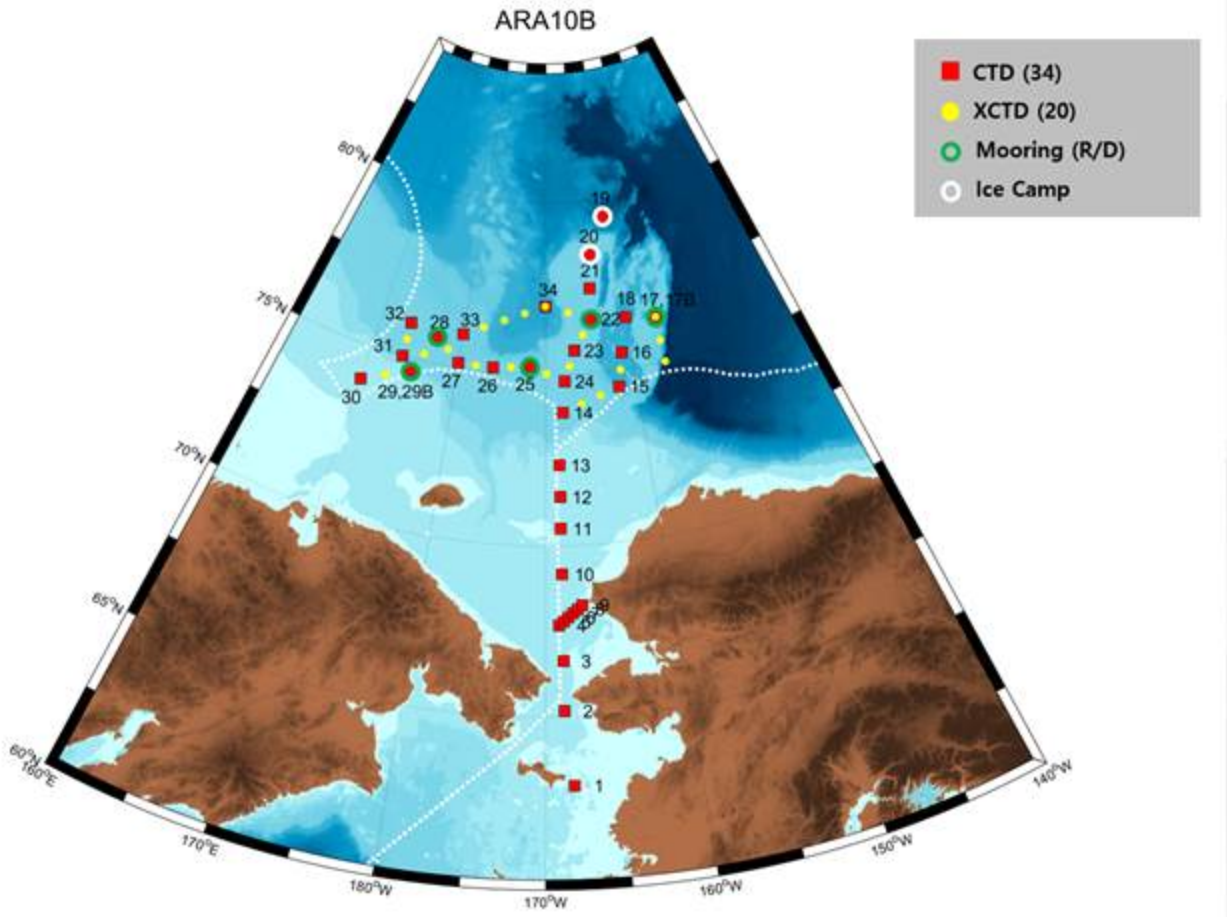
2019 KOPRI Arctic Ocean Expedition (1st leg)

- **Ocean-Sea Ice-Atmosphere Integrated Observations (Bering strait, 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 (STAR)
- **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:** 2019. 8.3 - 8.26 (from Dutch Harbor to Barrow)
- **Chief Scientists:** Eun-Jin Yang (ejyang@kopri.re.kr)
- **Participating nations:** Korea, Croatia, Germany, the UK, India, France, China

2019 ARAON Arctic Expedition (1st leg)

2019 Arctic Ocean Expedition

1st Leg (ocean-sea ice-atmosphere)

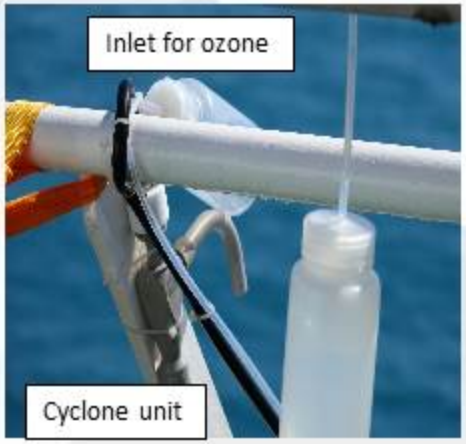


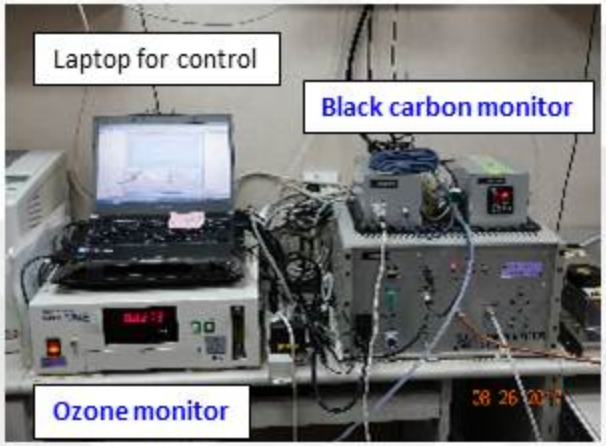
- North of Bering strait
- Chukchi shelf
- Chukchi Borderland to East Siberian Sea
- DBO line 3
- 2 Sea Ice stations
- Ocean mooring stations (5 set)

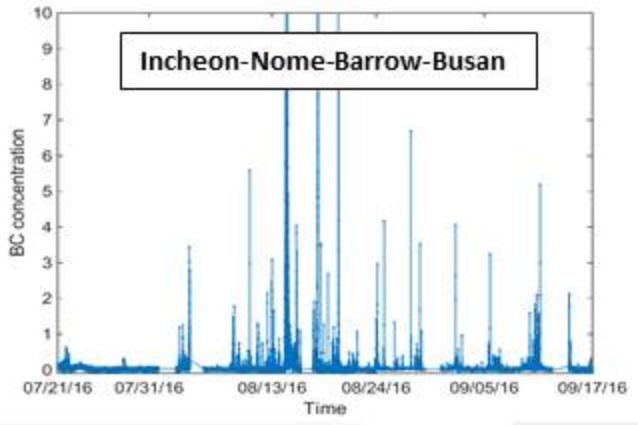
Atmospheric Observations

- 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.



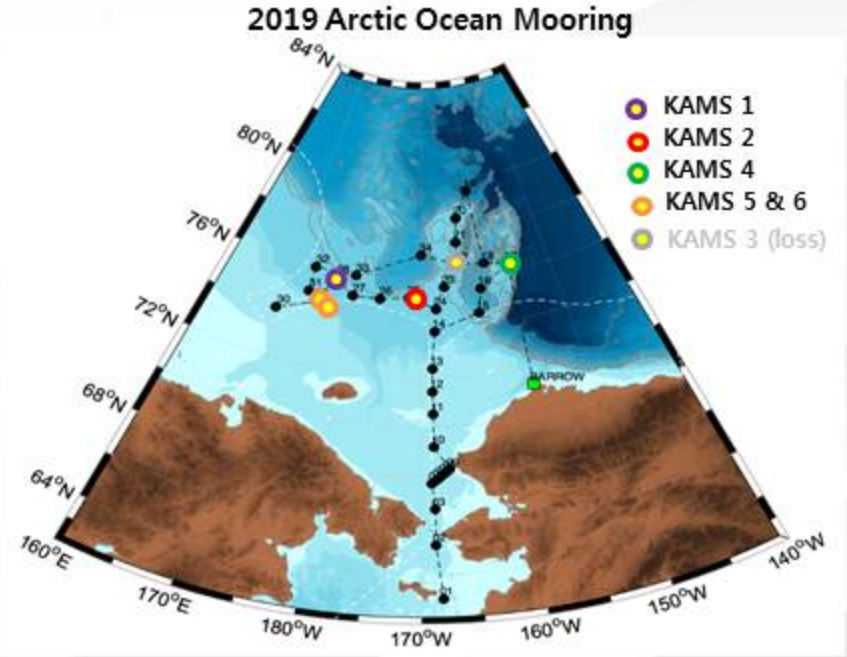


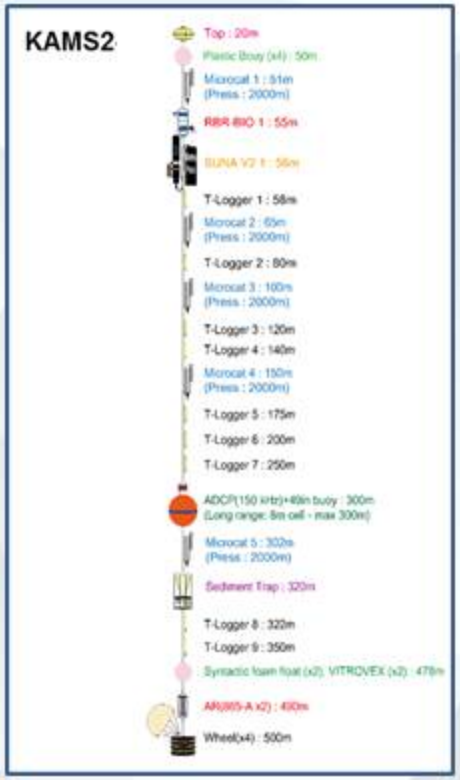


Preliminary result

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

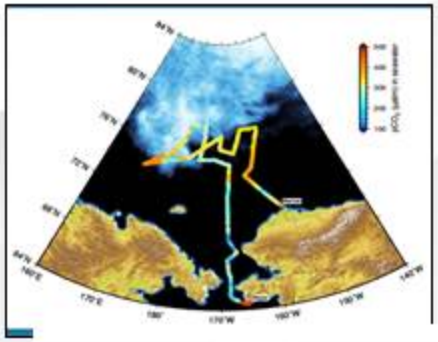




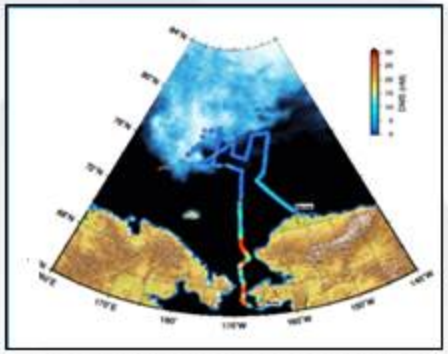
Chemical Oceanography

- Spatial and temporal variation of pCO_2 in the Arctic Ocean
- Characteristics of dissolved inorganic carbon (DIC)
- Net community production (NCP) using MIMS (Membrane-inlet Mass Spectrometry)

Continuous observation system of pCO_2



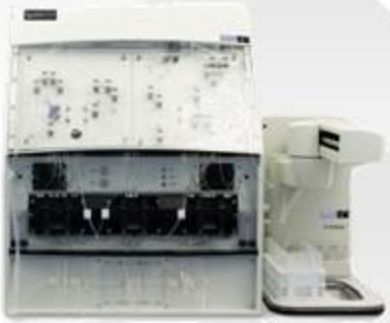
Dissolved pCO_2 along the track



Dissolved O2/Ar along the track

Continuous observation system (MMIS)

- Distributions of nutrients (NH_4, NO_2+NO_3, PO_4 and SiO_2)
- Characteristics of dissolved and particulate organic matters (DOM and POM)
- Distributions of river water and ice melt water
- Sinking particle flux



Seawater auto analyzer

TOC-TN analyzer

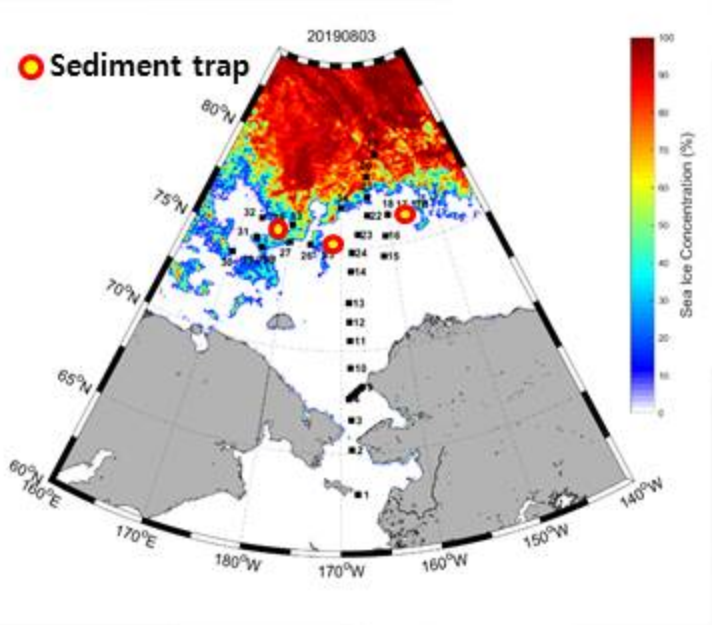
CHN analyzer

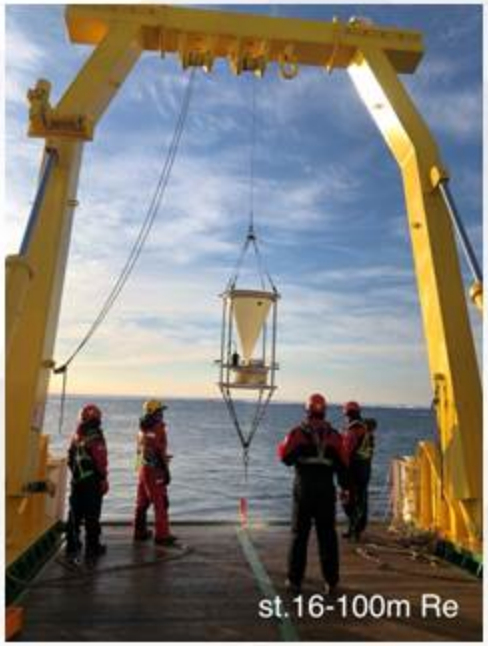
DOC sampler

Sediment trap

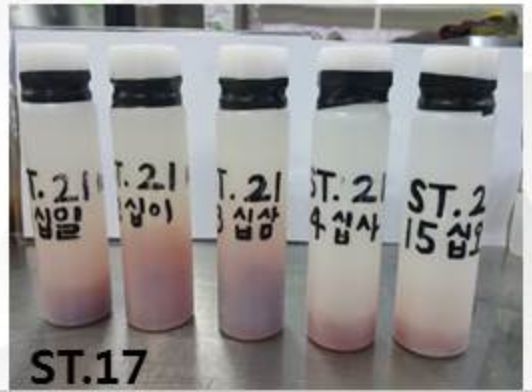
Seasonal variation of Particle flux

Sediment trap is the most powerful tool for investigating the carbon cycle changes in the Arctic Ocean



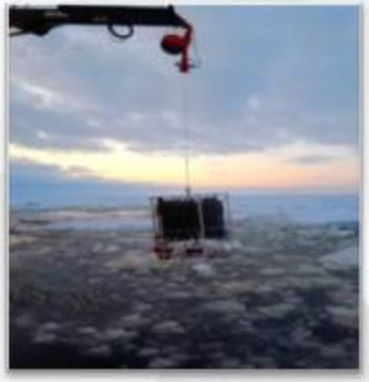


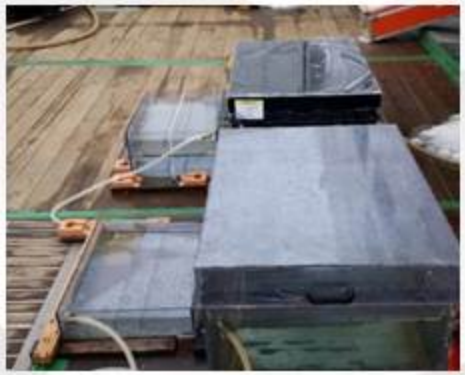
- ✓ East Siberian Sea
  -100m & 320m
  (only summer)
- ✓ Southern Chukchi Sea
  -100m
- ✓ Chukchi Borderland
  -100m & 500m

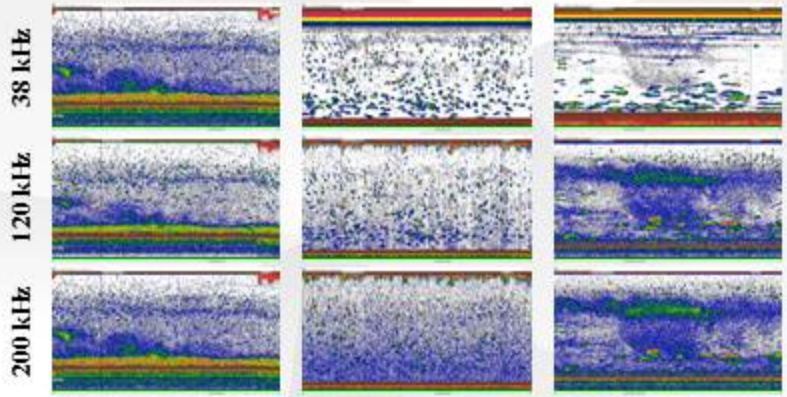


Biological Oceanography

- **Phytoplankton** community structure, Production, Physiology (F_v/F_m)
- **Microzooplankton** community structure and grazing impact
- **Mesozooplankton** population and community structure (biomass and Accoustic)
- **Bacteria and virus** abundance
- Planktonic **food web** **structure**







[Vertical variation of acoustic backscatter]

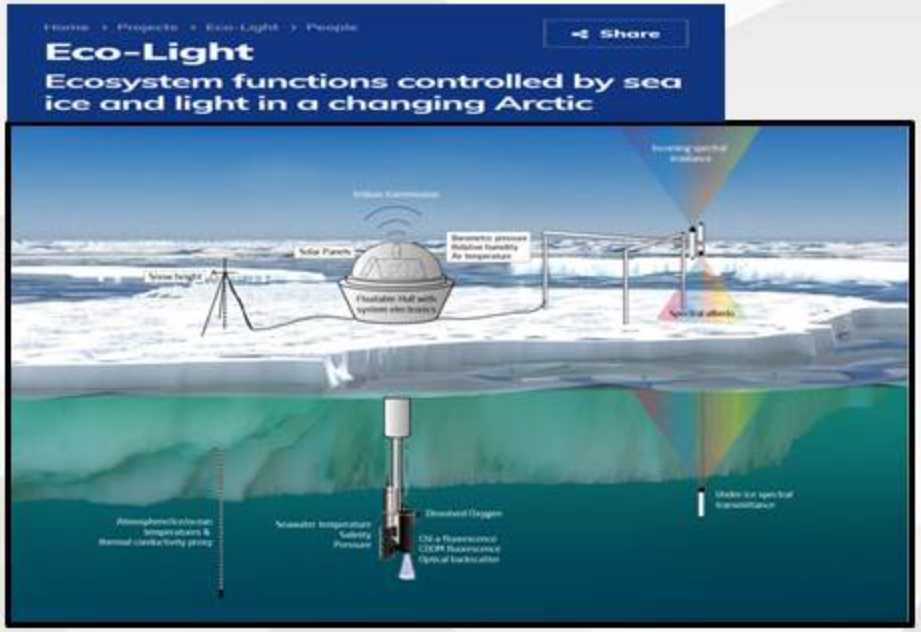
Sea ice bio-physics

- 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
- To define environmental characteristics of various melt ponds on sea ice floes
- International collaboration: KOPRI, BAS(UK), AWI(Germany), France (LOCEAN)


In-situ melt pond observation (KOPRI)


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


BAS (UK)



https://www.changing-arctic-ocean.ac.uk/project/eco-light/people/

(By Eco-Light program)

Remote Sensing

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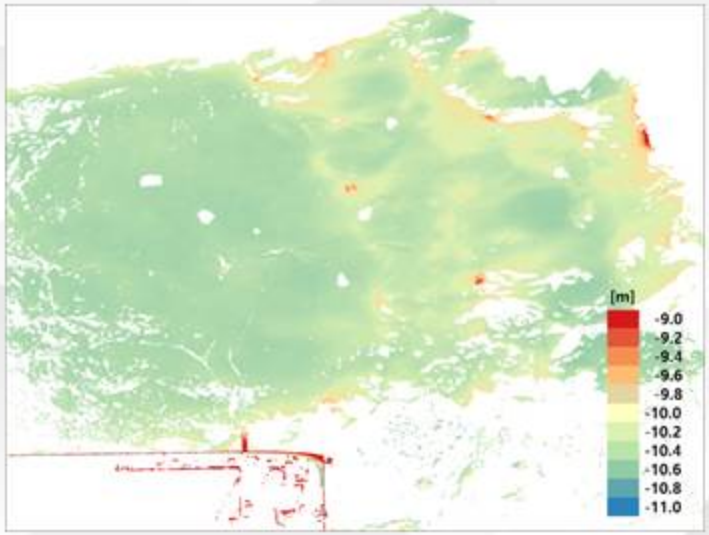
Ice Surface Scanning (ice surface roughness measurements)

- Sea ice surface roughness will be measured by using 3D laser scanner with 3 mm accuracy
- High-resolution satellite SAR images were acquired during the ice surface scanning
- Measured ice roughness will be compared to microwave backscattering derived from the SAR
- It is expect an algorithm for sea ice surface roughness estimates from satellite SAR is developed

Ice surface roughness measurement using 3D scanner

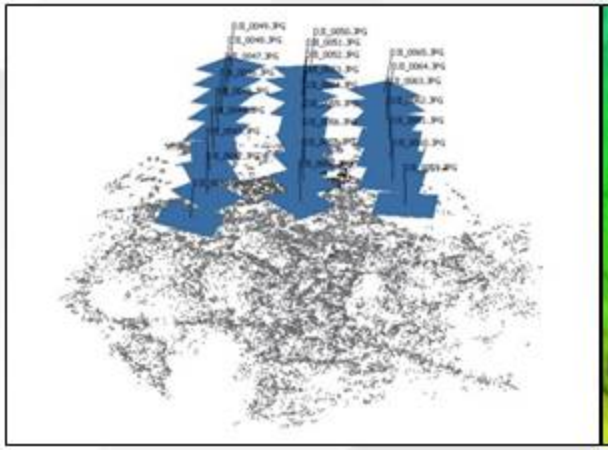


Preliminary result of ice surface roughness

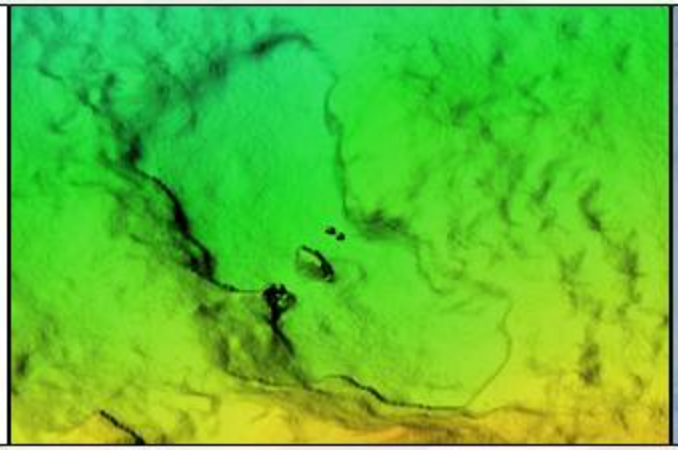
Remote Sensing

- UAV (unmanned aerial vehicle) observation (high-resolution image acquisition)

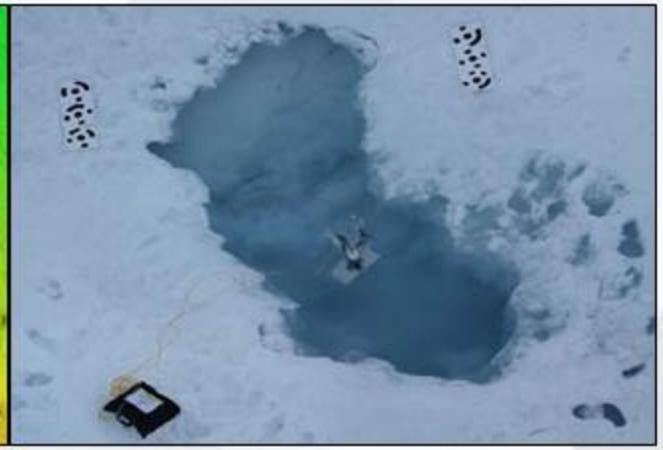
- Very-high-resolution (VHR) image acquisition using UAV over drifting arctic sea ice was conducted.
- The VHR images (a spatial resolution of few centimeters) were acquired in unfavorable cloudy conditions for optical satellite imagery acquisition.
- Digital elevation model and mosaicked image can be used for further analyses, e.g., sea ice surface roughness measurement, melt pond distribution analysis and satellite data derived sea ice product validation.



UAV image acquisition strategy



Preliminary result of sea ice surface topography



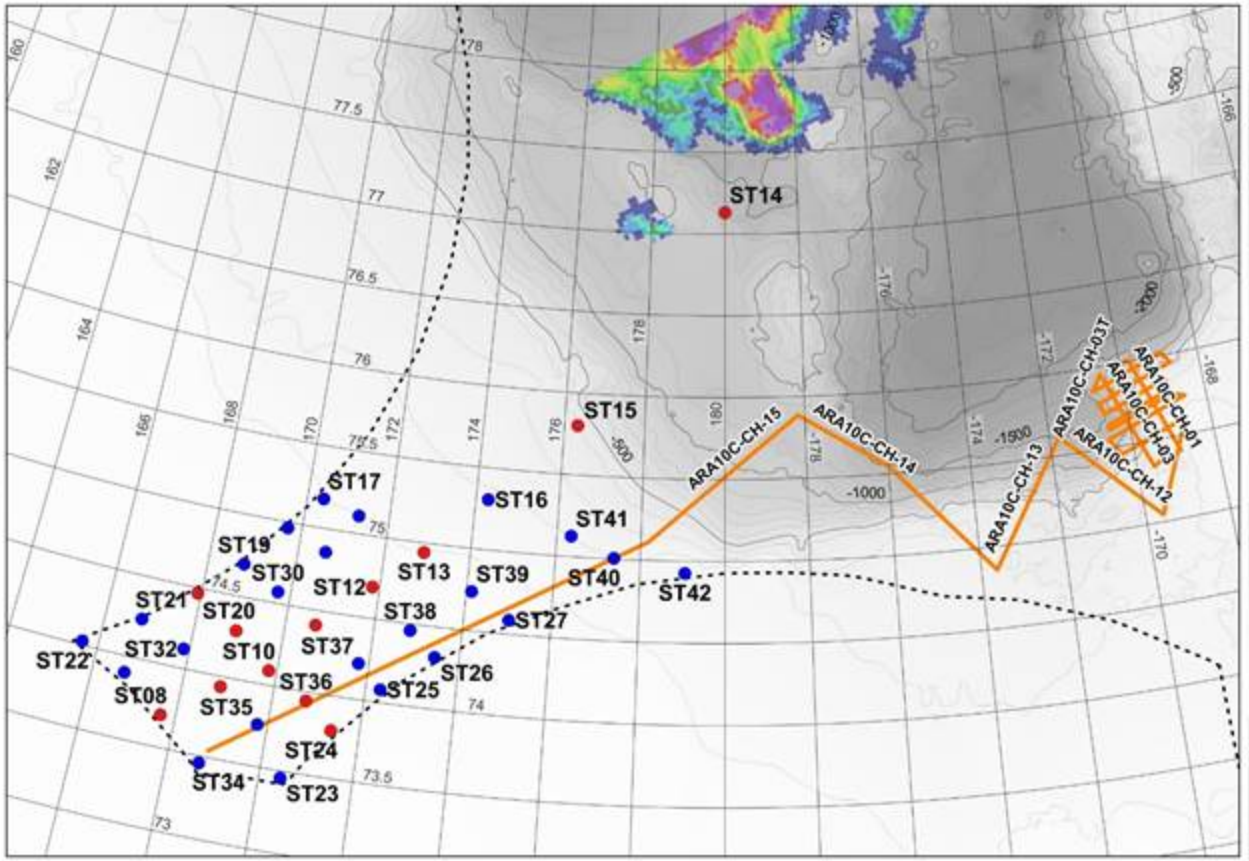
Preliminary result of mosaicked image

2019 KOPRI Arctic Expedition (2rd Leg)

- Marine geology/geophysics/biology (East Siberian Sea)
- Aims of the cruise:
  - To map geological features/structures in the Arctic continental margin
  - To examine subsurface geology, permafrost, and gas hydrate and/or free gas accumulation, methane cycle, and methane-related microbiology in the Arctic
  - To document subsea bed geological processes, such as permafrost degradation, submarine slope failure, and methane release on the Arctic shelf/slope
- Period: 2019. 8.29 - 9.20 (from Barrow to Nome)
- Number of participants: 40
- Chief Scientists: Dr. Young-Keun Jin (ykjin@kopri.re.kr)
- Participating nations: Korea, Russia, Germany

2019 Arctic Expedition (2nd Leg)

Study Area: East Siberian Sea



- Research items;
  - Multichannel seismic survey
  - OBS survey
  - Sub-bottom profiling
  - bathymetric mapping
  - Sediment coring
  - Heat flow measurements
  - Water column study
  - Methane flux study
  - Microbiological study

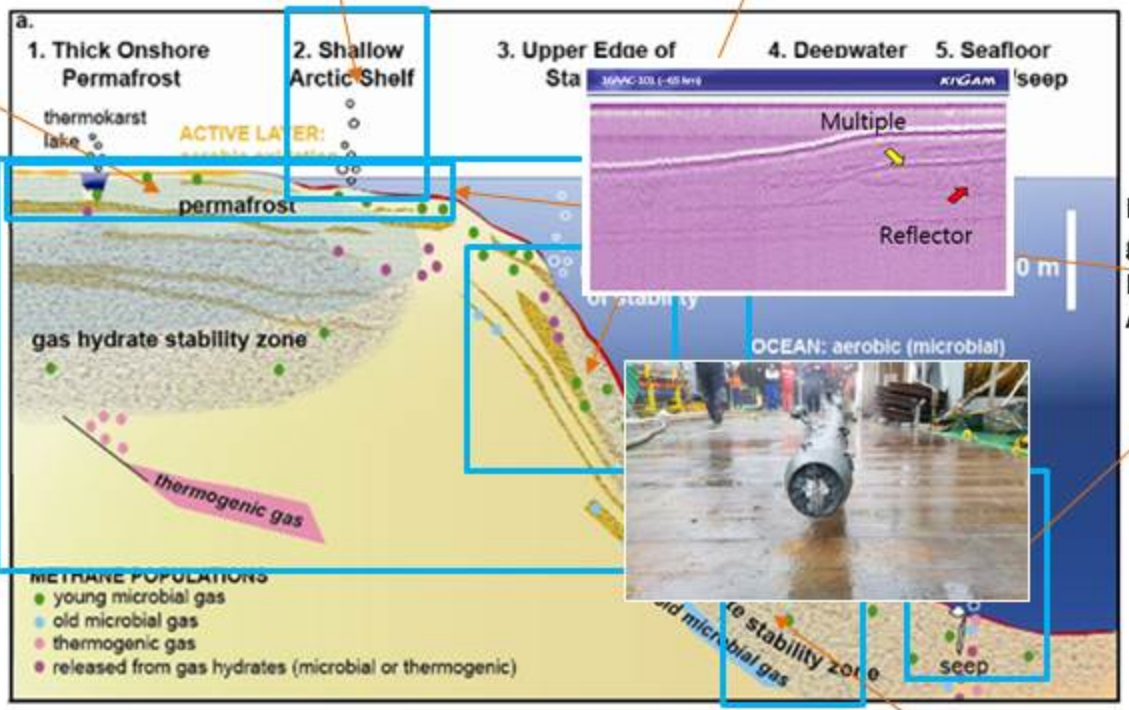
2019 Arctic Expedition diagram (2nd Leg)

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

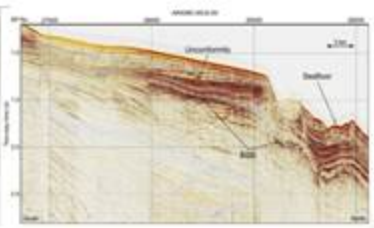
Geophysical mapping
Paleo-environment
Marine Geology

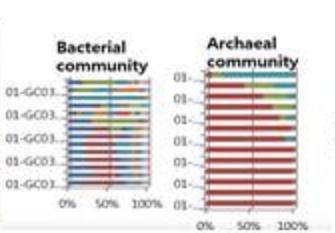


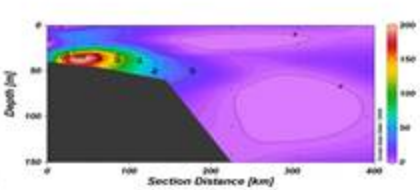
Ruppel, Nature Knowledge, Hydrates/Climate, April 2011

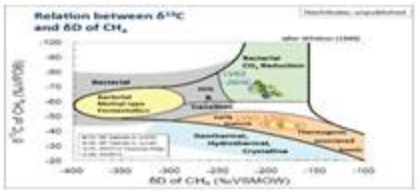
biomarker study for methane
generation/ consumption
processes microbiological study
/organic chemistry

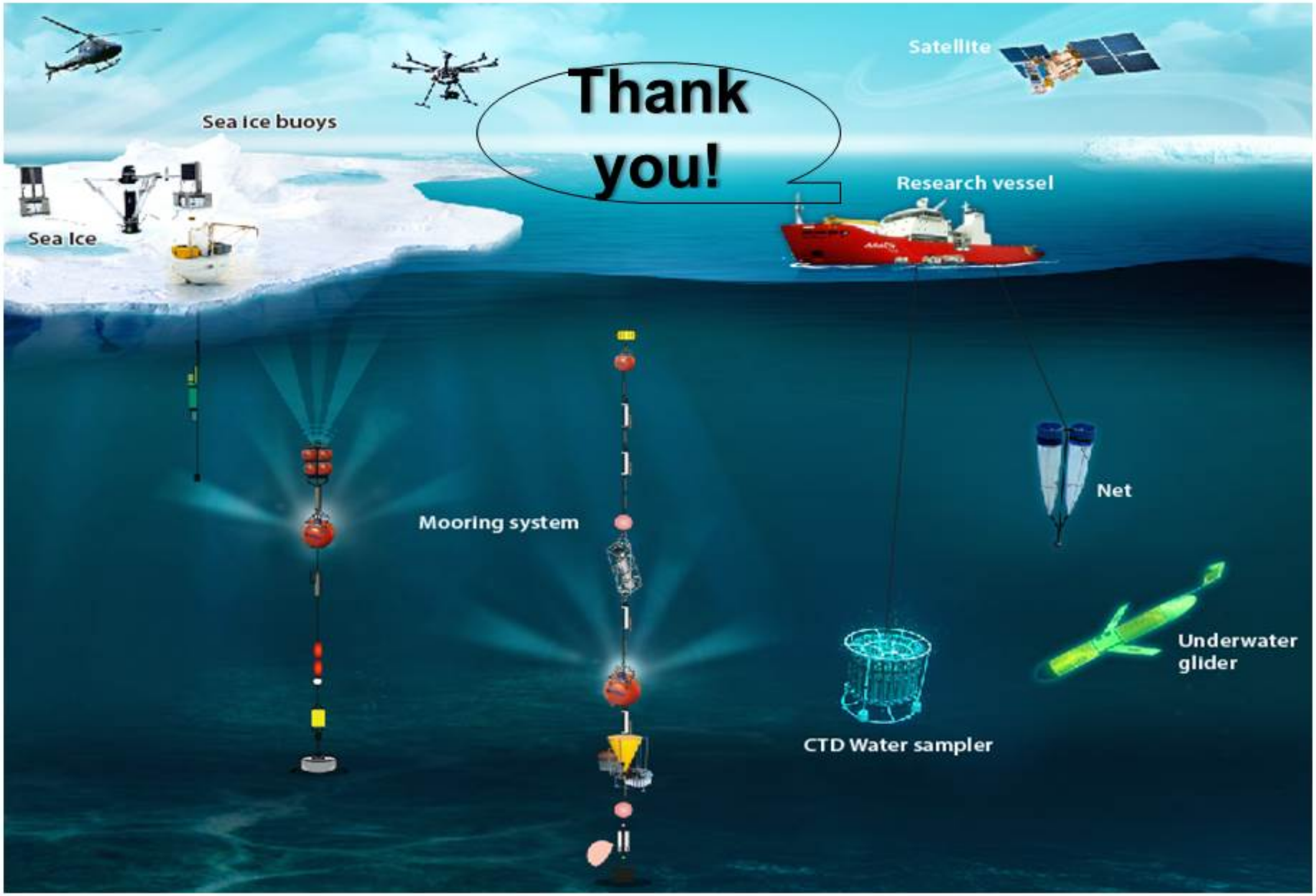
mapping of gas hydrate
distribution & stability










Thank you!
Satellite
Sea ice buoys
Research vessel
Sea Ice
Net
Mooring system
Underwater glider
CTD Water sampler