Korea Arctic Ocean Cruise

November 16, 2011

Kyung Ho Chung, Korea Polar Research Institute

Arctic Ocean Cruise 2011

- **Purpose:**

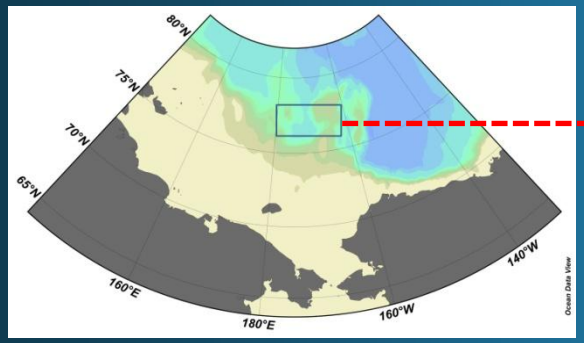
  - Multidisciplinary studies to monitor ongoing environmental changes and its effects on the Chukchi Sea, western Arctic Ocean

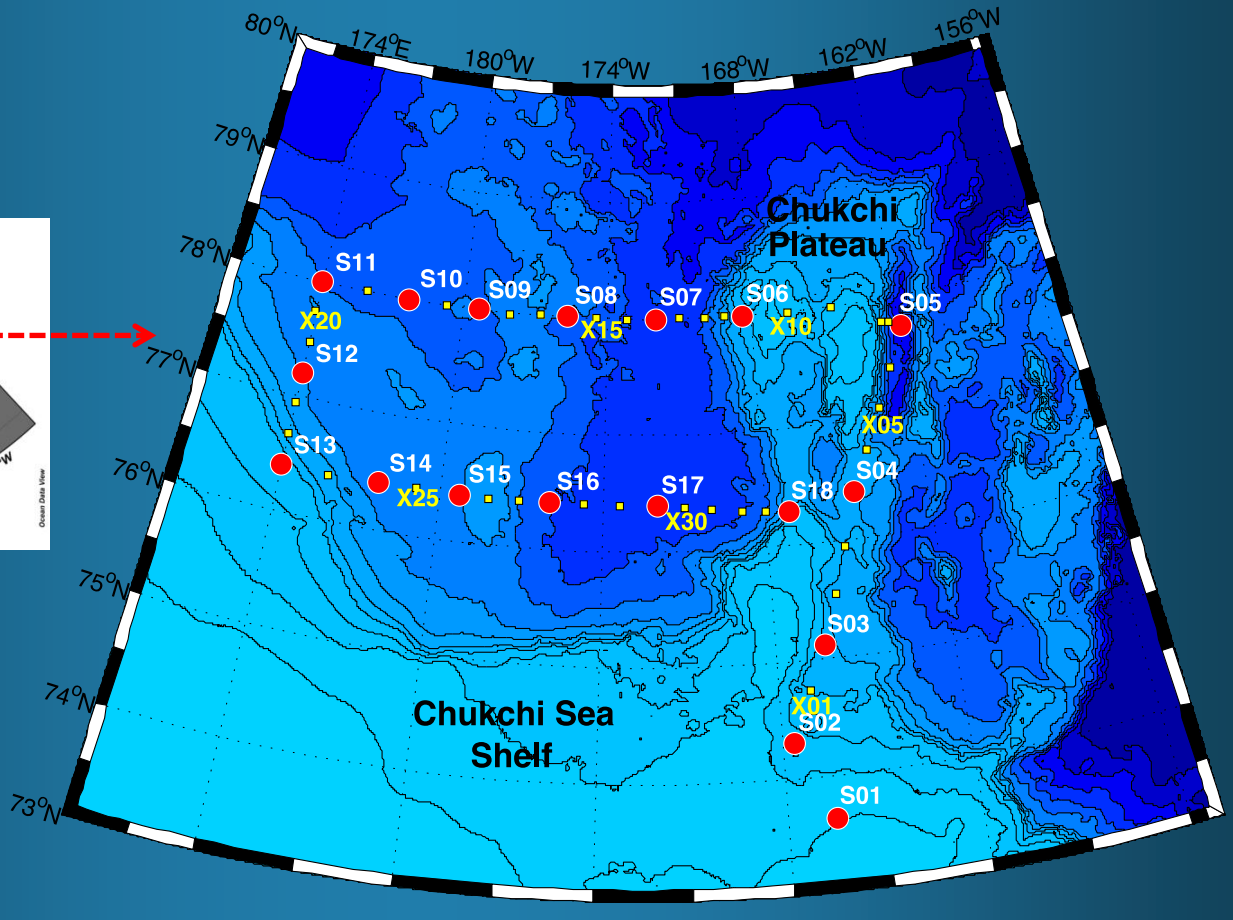
- **Period**: 2011. 07.31 ~ 08.20 (Nome to Nome)

- **Participants**: 40 (Korea 29, UK 2, Spain 1, Russia 2, Japan 3, China 2)

- **Research fields**:
  - Atmospheric observation
  - Satellite remote sensing
  - PCO_2 measurement
  - Hydrographic survey
  - Microbes & Plankton ecology
  - Sea ice study
  - Melt pond (ice algae) study
  - Paleoceanography

Study area


80°N
75°N
70°N
65°N
160°E
180°E
160°W
140°W
Ocean Data View


80°N
174°E
180°W
174°W
168°W
162°W
156°W
79°N
78°N
77°N
76°N
75°N
74°N
73°N
Chukchi Plateau
Chukchi Sea Shelf
S11
S10
S09
S08
S07
S06
S05
X20
X15
X10
S12
X05
S13
S14
S15
S16
S17
S18
S04
X25
X30
S03
X01
S02
S01
4000
3500
3000
2500
2000
1500
1000
500
0

Atmospheric observation

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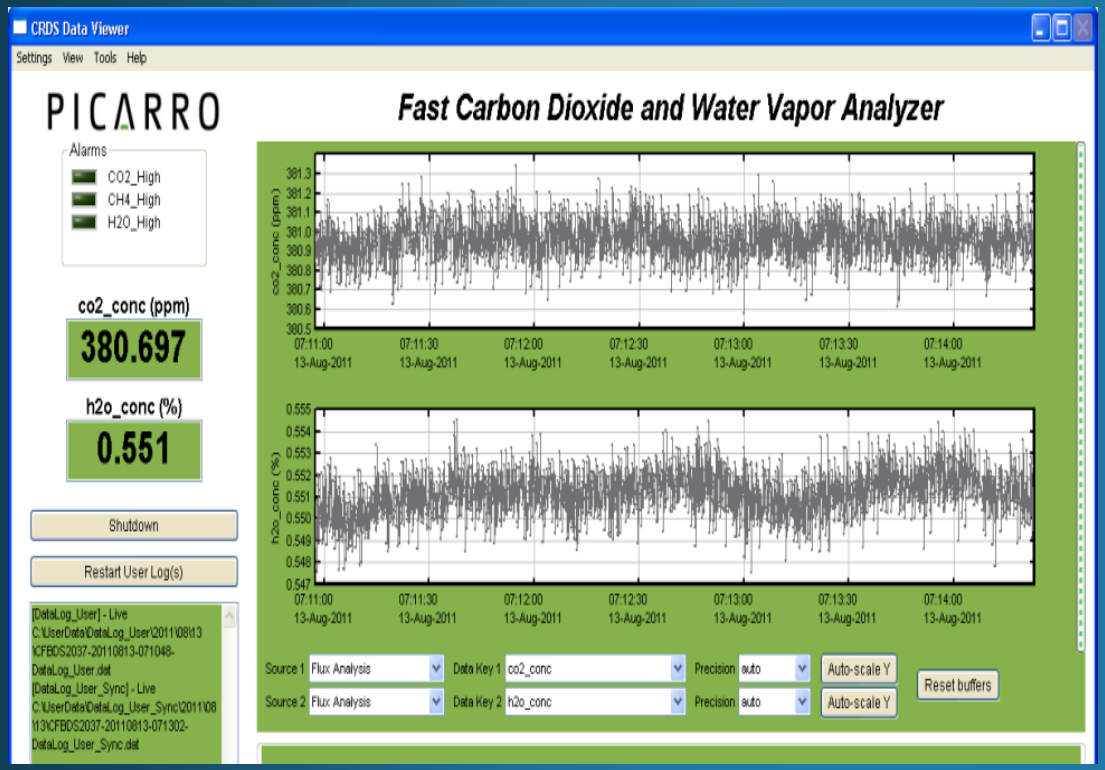
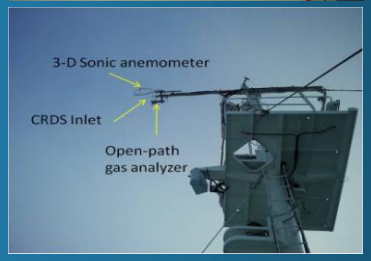
Greenhouse gases(CO_2, CH_4) & Aerosol measurement (in situ)

- To better understand the effect of decreased sea ice on the atmosphere
- To test on board atmospheric instrument to improve them for in-situ measurements





CO_2 & CH_4 measurement : Wave-scanned cavity ring-down (CRDS) analyzer

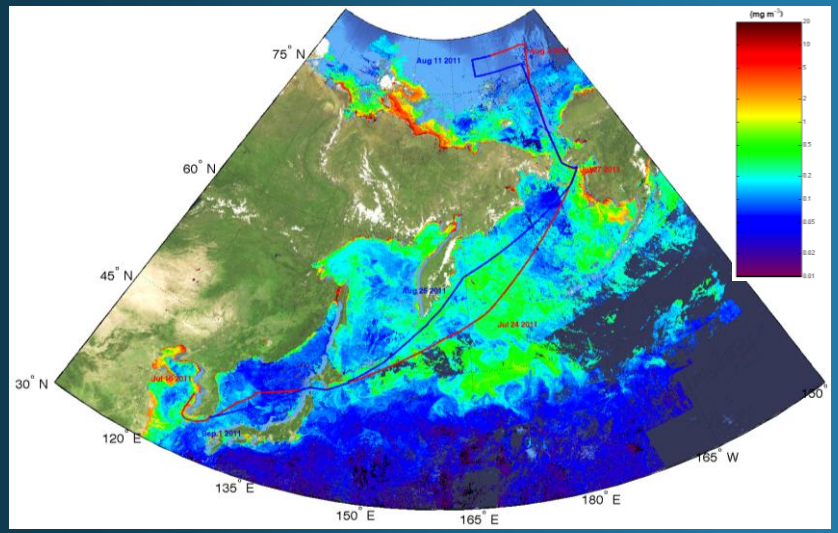
Aerosol measurement: LIDAR/sunphotometer

Satellite remote sensing

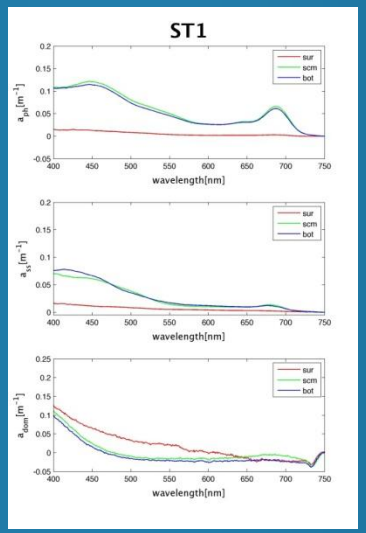
Hyun-cheol Kim: kimhc@kopri.re.kr

Ocean color remote sensing

- Hyper-spectro radiometer
  - above water reflectance (radiance350-900nm) measure through ship(ARON) track
  - CAL/VAL ocean color data on high latitude
- Absorption by phytoplankton, SS (suspended sediments), and CDOM (colored dissolved organic matters)
  - bio-optical properties on Arctic sea and improve accuracy of ocean color data



CAL/VAL Ocean color data
In-situ reflectance vs. satellite reflec.



CAL/VAL Ocean color data
Absorption by Phyto, SS, CDOM

pCO_2 measurement

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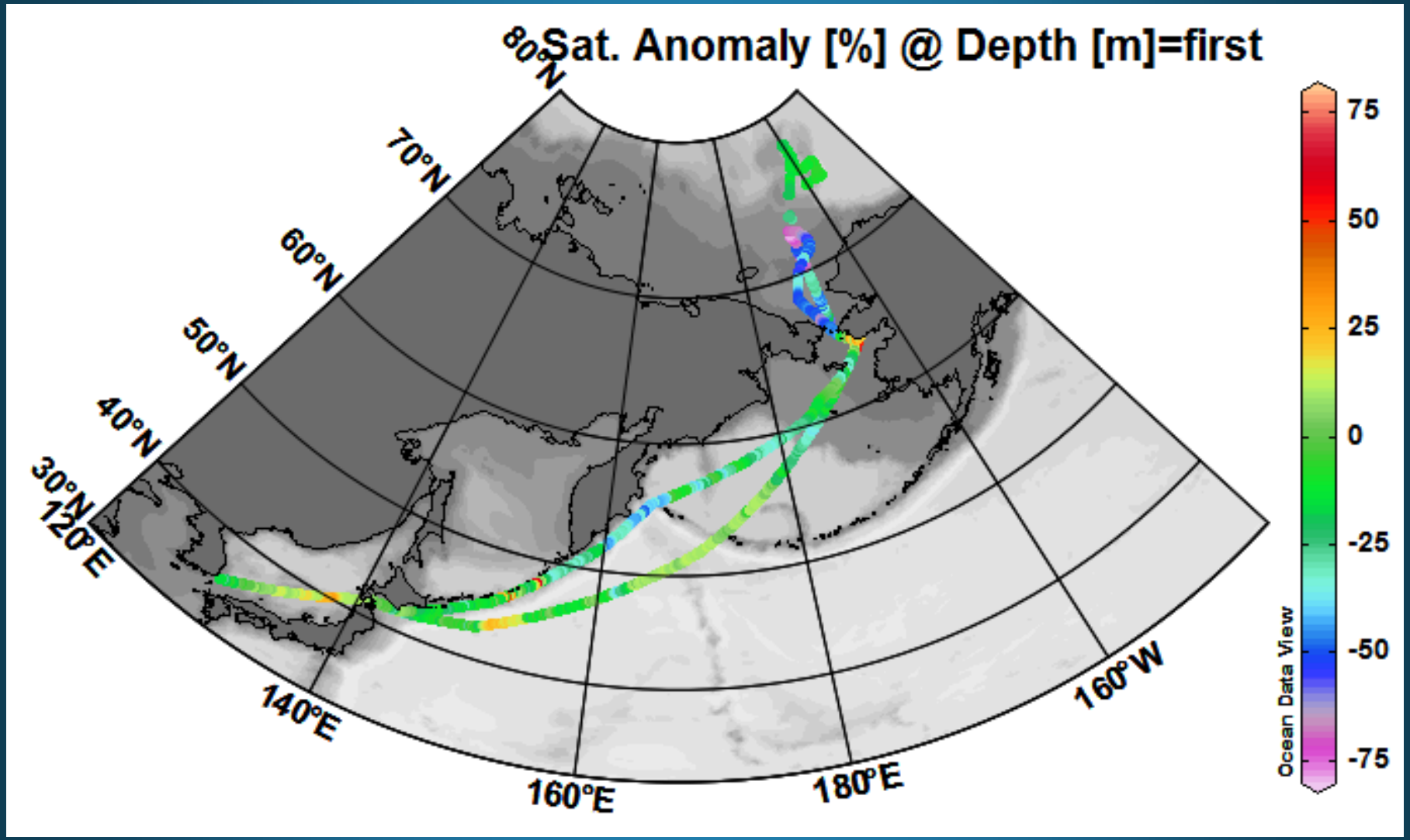

Hydrographic survey

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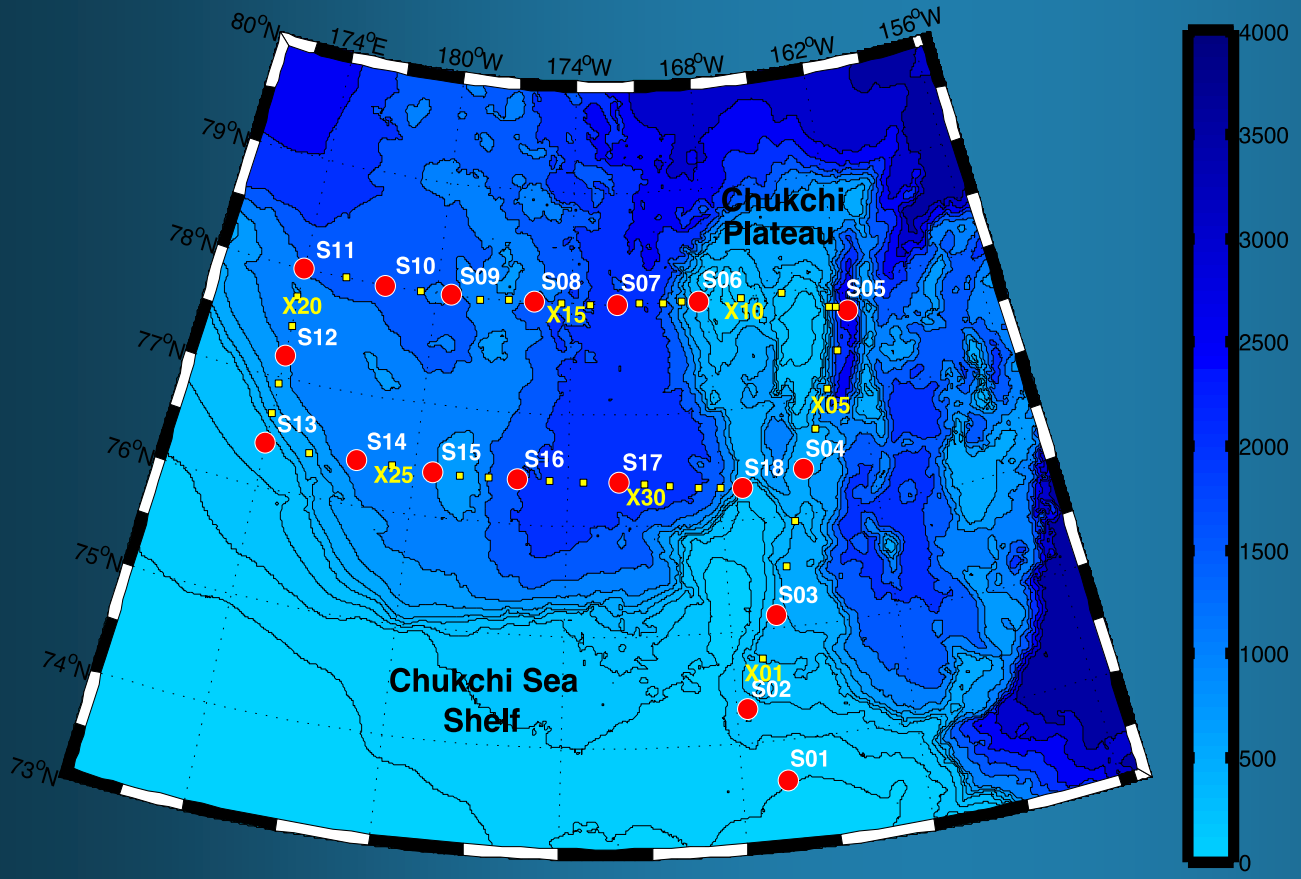
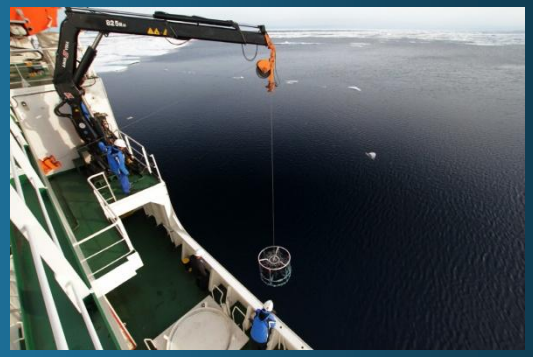
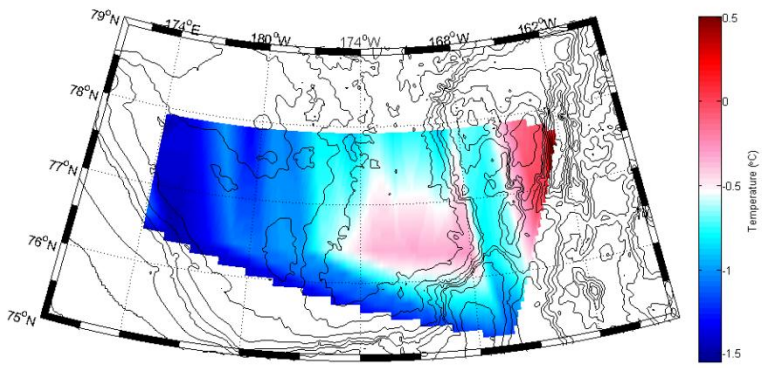
Water mass distribution & characteristics in Chukchi Boderland/Mendeleev Ridge

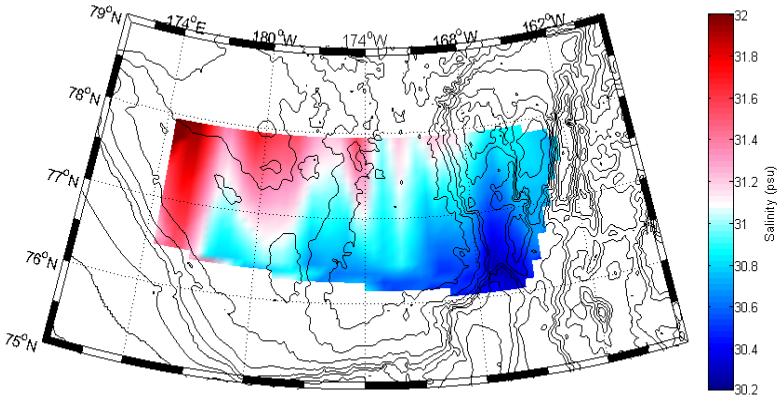
- Variability in spatial & temporal distribution of water mass
- Its transformation (changes in Temp. & Sal.) along the pathways

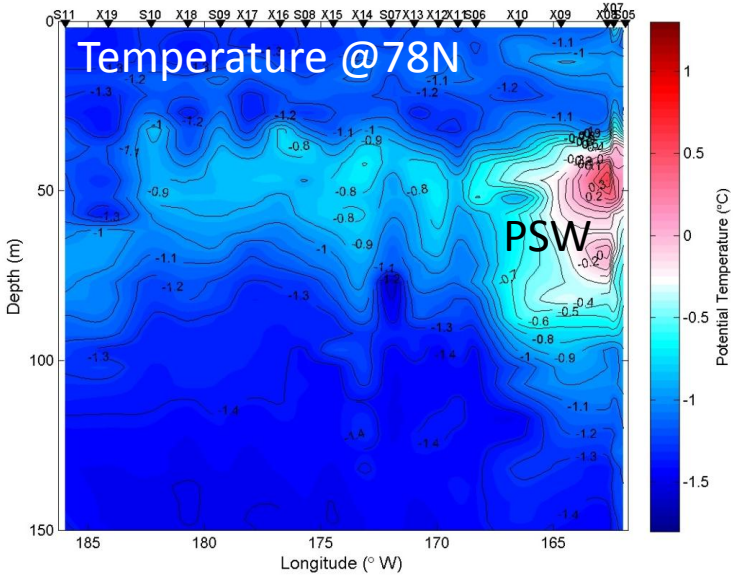


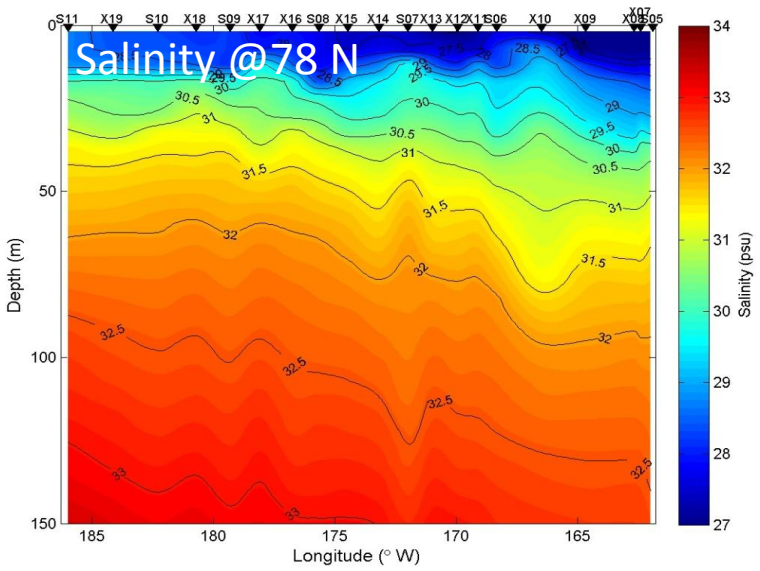


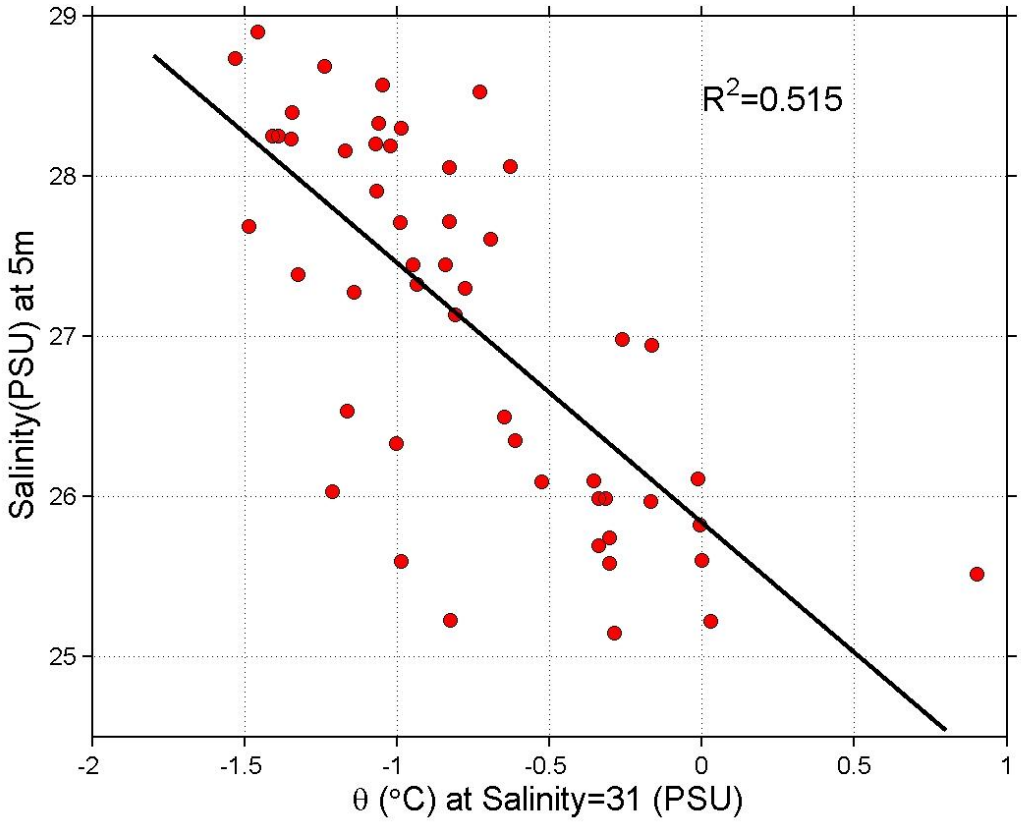
T-S distribution











Relationship between potential temperature at S=31 psu and salinity at 5m deep

Microbes Ecology

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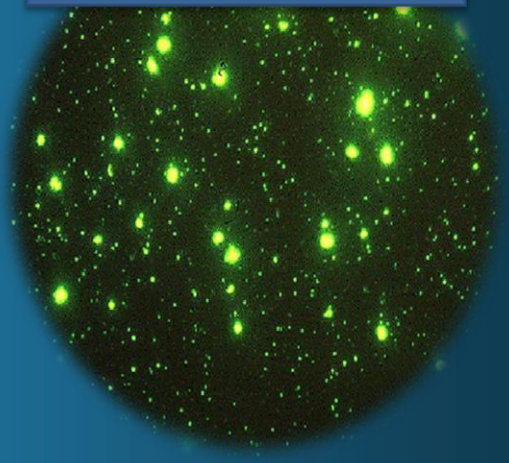
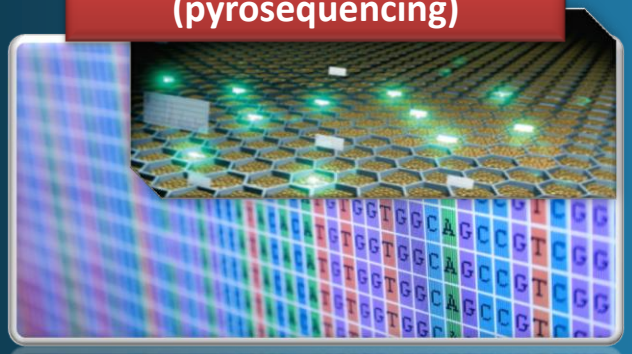
Distributions and diversities of bacteria and viruses

- Open Ocean
  - Links between bacterial and viral communities
- Deep-Sea Sediment
  - Bacterial diversity and biogeography
- Sea Ice
  - Isolations and characterizations of psychrophilic bacteria and cold active viruses

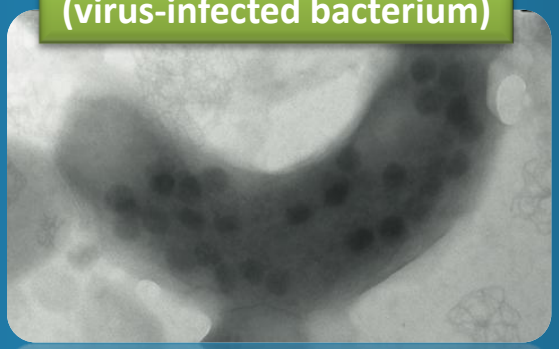
Bacteria and viruses (most abundant in seas)



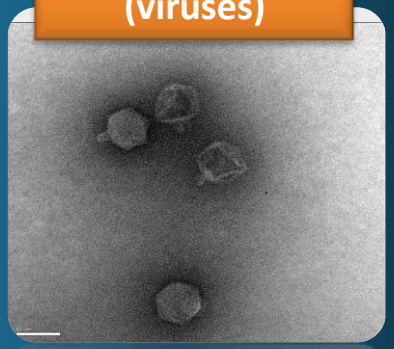
Community analyses (pyrosequencing)



Interactions (virus-infected bacterium)



Isolations (viruses)



Plankton Ecology

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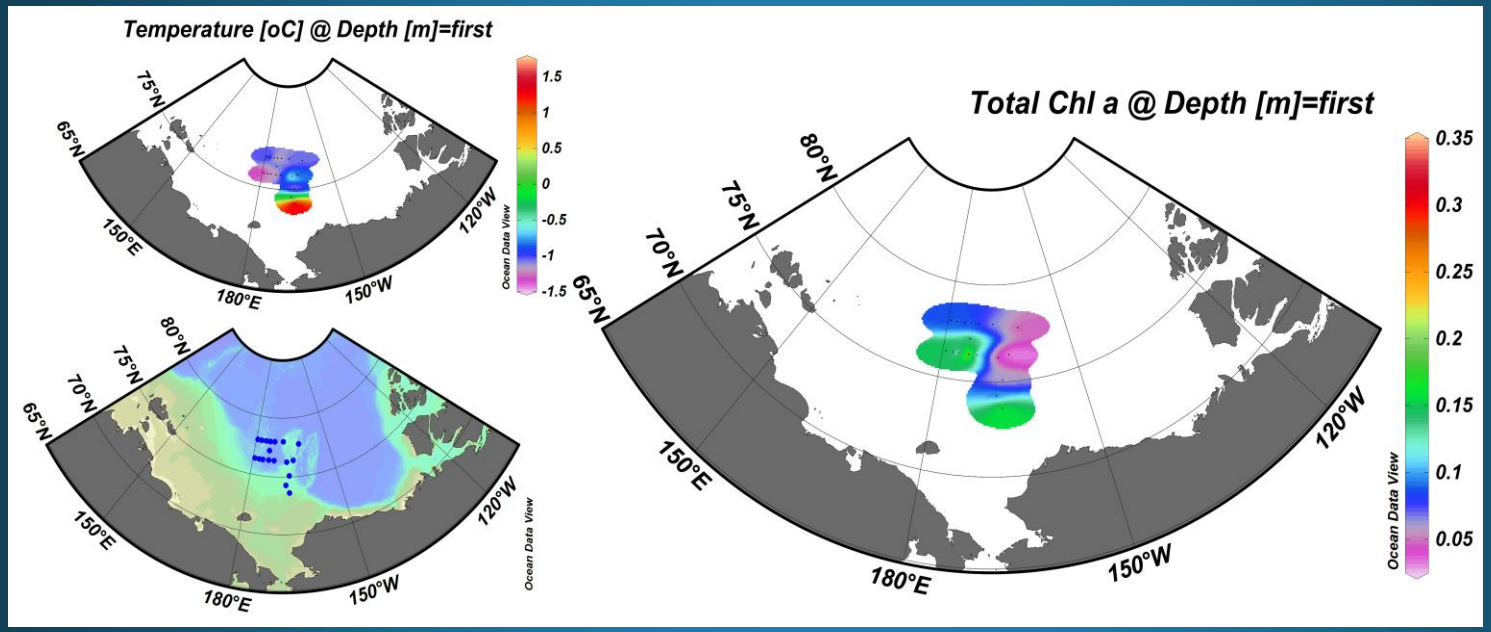
Phytoplankton community

- To understand temporal and spatial fluctuations of environmental factors affecting on physical/ecological mechanisms of phytoplankton
- To measure the relative importance of the environmental factors affecting on the phytoplankton



Plankton Ecology

Doo Byoul Lee: copepod@kopri.re.kr

Zooplankton community

- Temporal and spatial distribution
- Changing patterns of zooplankton community structures at the species- specific level (composition and dominance)
- Key species to detect the environmental changes
- Feeding rates of abundant copepods and the impact of copepod grazing on the phytoplankton biomass.

- Methods :
  - Sampling gear : Bongo net (333, 505 ㎛)
    Target depth of sampling : 200 m
  - Gut contents analysis
  - Statistical analysis
    Pearson correlation analysis
    Cluster analysis

Underway measurement

Continuously sampling area: Nome – Study area – Nome (except US EEZ)

Sampling parameters

In vivo chlorophyll a, Temperature, Salinity

Nutrients (SiO_2, NO_3+NO_2, NH_4, PO_4)

Physiological parameters (Fv/Fm, σPSII , 1/τPSII)

How many?

In vivo chlorophyll-*a*, Temperature, Salinity: continuously

nutrient: every 4 hours

FIRe (Rutgers Univ.)

10-AU fluorometer

Nutrient AA

Sea Ice Study

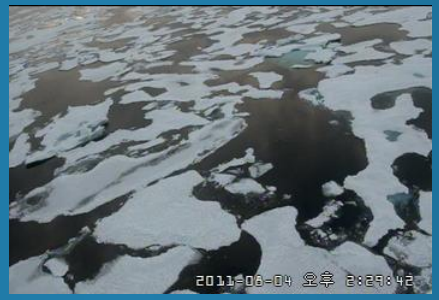
Hyun-cheol Kim: kimhc@kopri.re.kr

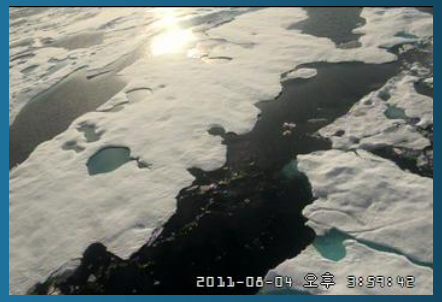
Sea ice pattern capture

- Real time mapping
  - Ice breaker navigation
- Satellite sea Ice data CAL/VAL
  - Improve accuracy of sea ice data from microwave satellite
- Seaice pattern grouping
  - Pattern group by ocean environmental condition (T, S, wind, air temperature)

Arctic

2011.Aug





Suthern Ocean

2011.Jan

Sea Ice Study

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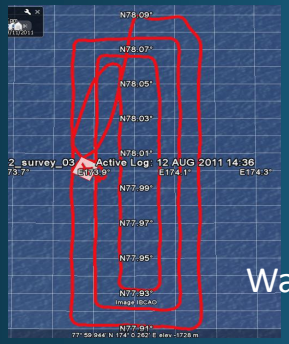
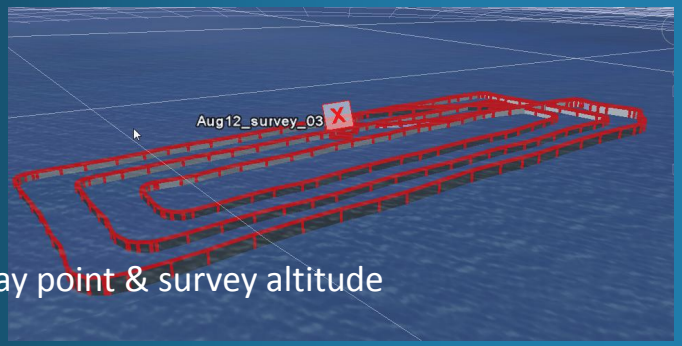
Airborne (helicopter) SAR survey

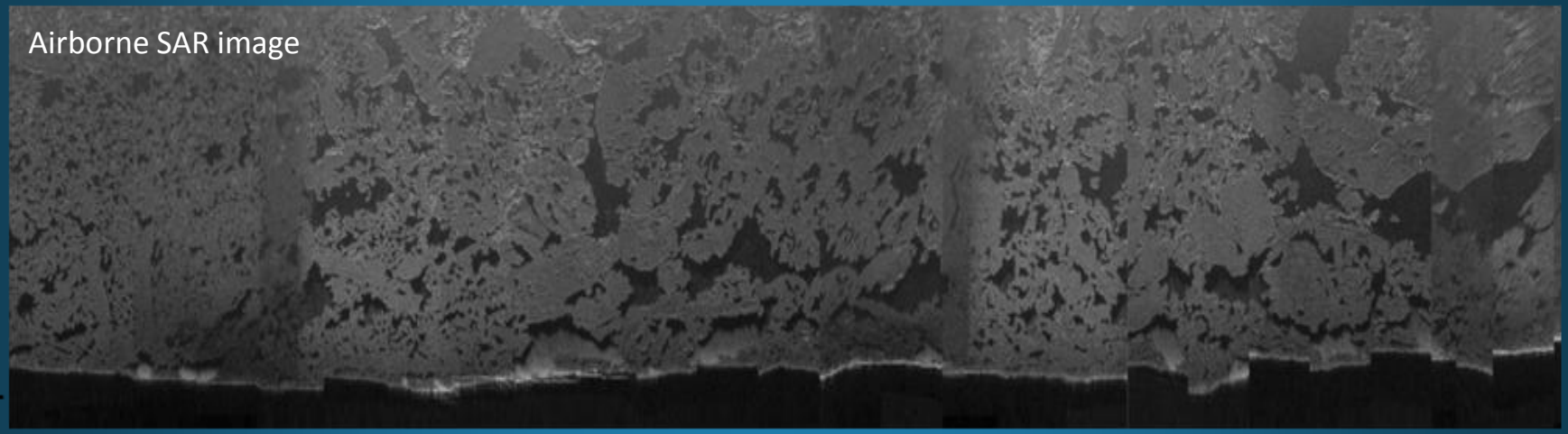
- To acquire ground-truth data for the calibration and validation of the satellite observations
- To test feasibility of helicopter-based airborne SAR system for the future measurements





Way point & survey altitude

far 05:02 UTC time



near

Sea Ice Study

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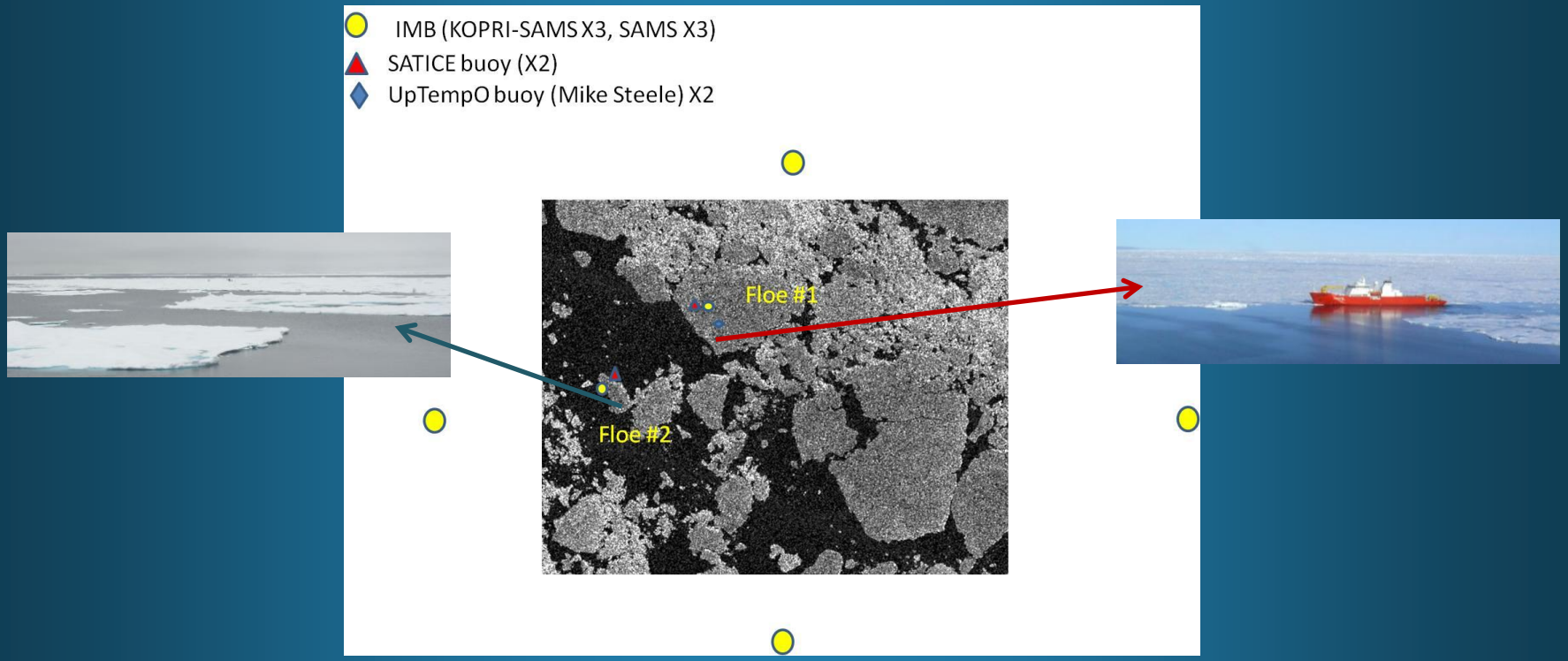
Buoy deployment

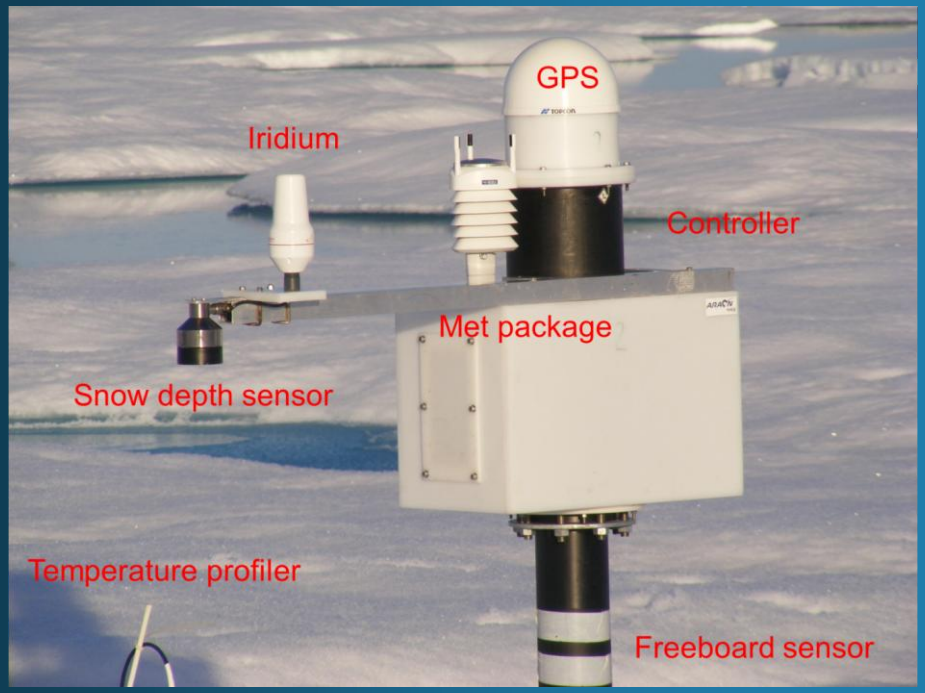
- Accurate and continuous measurements of sea ice dynamic and upper-ocean properties in the Arctic Ocean are crucial for an improved understanding of the mechanisms behind these recent abrupt changes, and to identify/improve the shortcomings of climate models

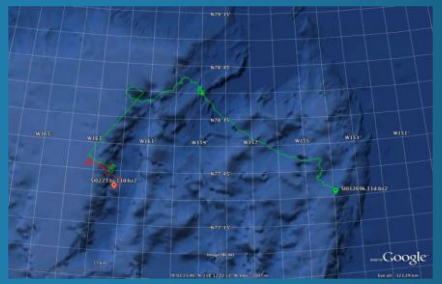


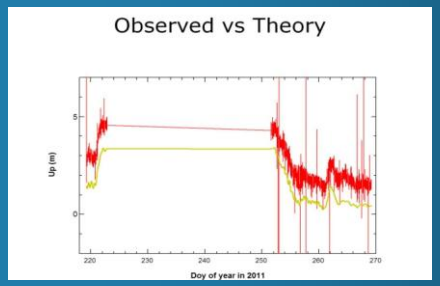
SATICE buoy

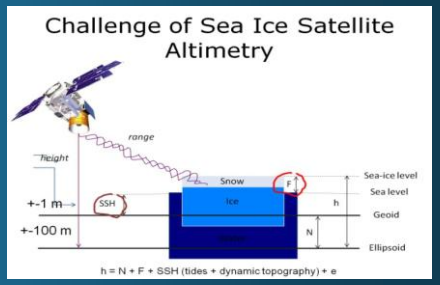
Parameters: high precision position, snow depth, freeboard, meteorological variables

- It can measure sea ice/ocean dynamics to within a few centimeters precision.
- It will be used to study tides, ocean circulation, ocean dynamic topography, sea-ice freeboard heights, ice thickness and sea ice mass balance in the Arctic ocean.





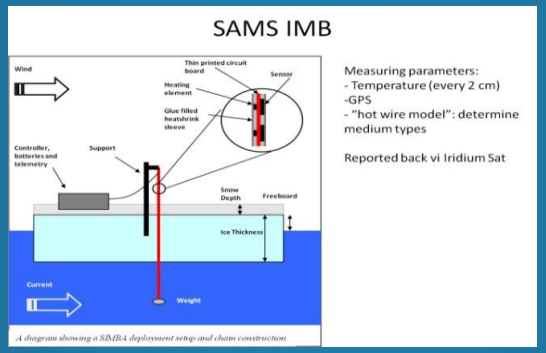




SAMS Ice Mass Balance Buoy (SIMAB)

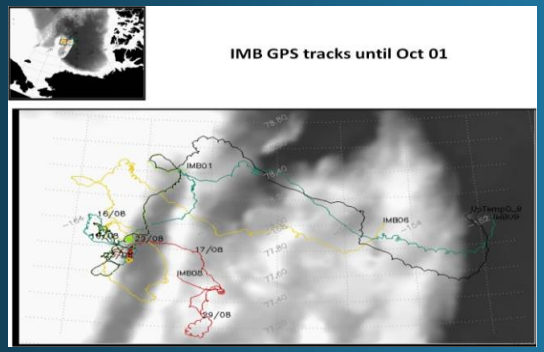
Parameters: GPS location, temperature profiles(air, ice, water), ice growth/melt (from 'hot wire' technique)

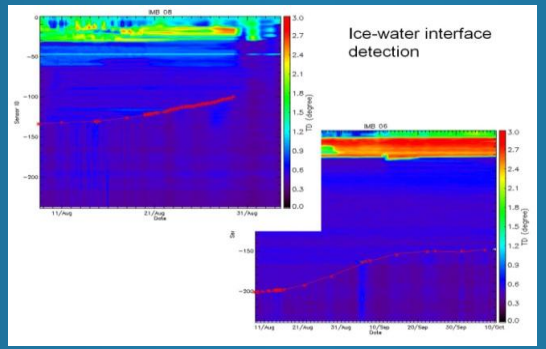
SIMBA consists of a thermistor string (about 5-meter long), a GPS and Iridium transmitter/receiver. The thermistors of the string are spaced every 2 cm with 'hot-wire' capability, which is used to delineate the surrounded media (i.e., air, snow, ice and water) based on different thermal conductivity of the media



Status of IMBs

ID	Institute	Date Deployed	Date last transmission	Ice Thickness (m)	Snow Depth (m)	Freeboard (m)
01	SAMS	07/Aug/11	10/Sept/11	2.60	0.08	0.52
05	SAMS	07/Aug/11	17/Aug/11	2.90	0.07	0.30
06	SAMS	07/Aug/11	ongoing	3.74	0.04	n/a
07	KOPRI/ SAMS	07/Aug/11	10/Sept/11	2.96	0.05	0.31
08	KOPRI/ SAMS	07/Aug/11	03/Sept/11	3.74	0.04	n/a
09	KOPRI/ SAMS	08/Aug/11	ongoing	3.50	n/a	0.50





Bottom Melt Rate and Initial Ice Thickness

Total bottom melt and mean bottom melt rate (August 8 to September 3)

IMB ID	Total melt (cm)	Melt rate (cm/d)
01	29.5	1.1
06	62.8	2.4
08	92.1	3.5
09	45.0	1.7

Andrey's observation (Ice Navigator)

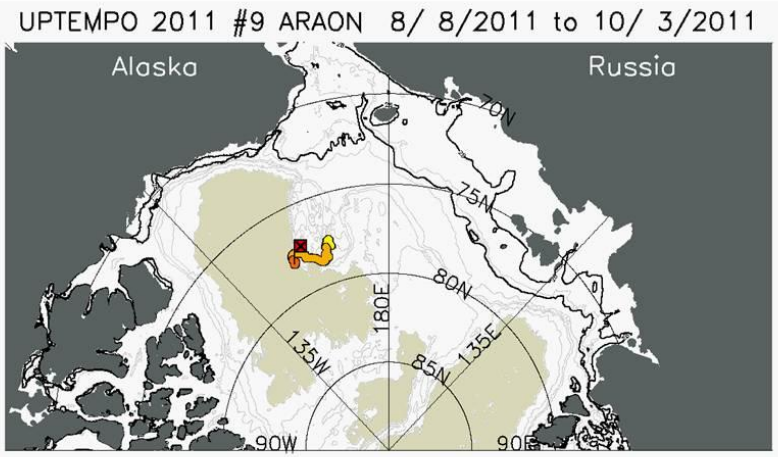
About 40-65% of first year ice of thickness of 30 to 70 cm on August 7-8.

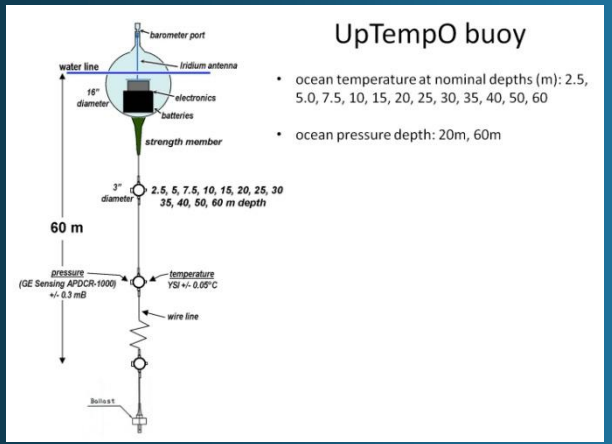
Bottom melt was sufficient to melt out the range of first year ice floes!

UpTempO Buoy

UpTempO#9

Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec

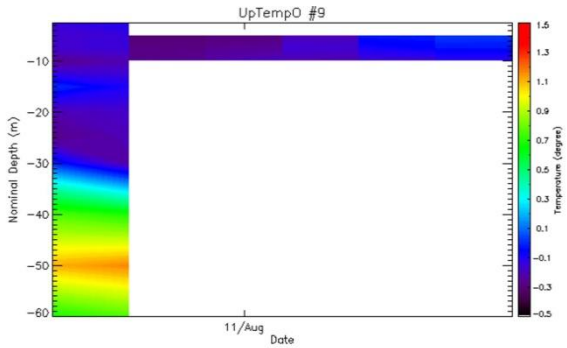




UpTempO buoy

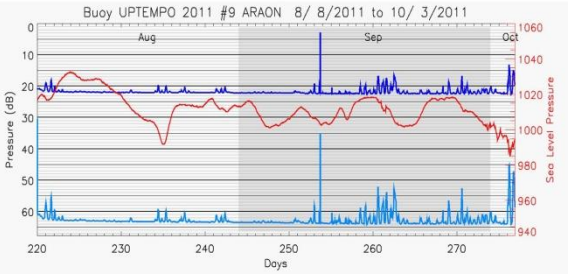
- ocean temperature at nominal depths (m): 2.5, 5.0, 7.5, 10, 15, 20, 25, 30, 35, 40, 50, 60
- ocean pressure depth: 20m, 60m

TEMPERATURE TIME SERIES



OCEAN PRESSURE AND SEA LEVEL PRESSURE

the ocean pressure(s) from the barometers placed at nominal depths (blue), and sea level pressure in red



Melt Pond study

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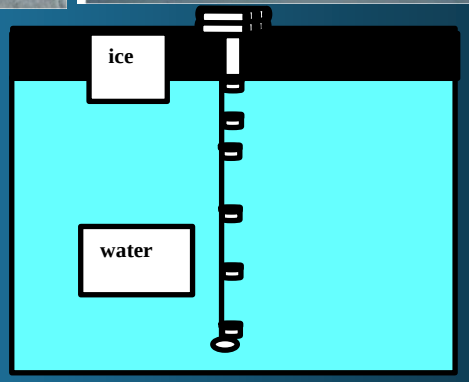
Productions & macromolecular composition of ice algae

- Controlling factors for ice algal C/N production
- Comparing macromolecular compositions of different size fractionated ice algae
- Effect of light intensity under different sea ice thicknesses on primary productions

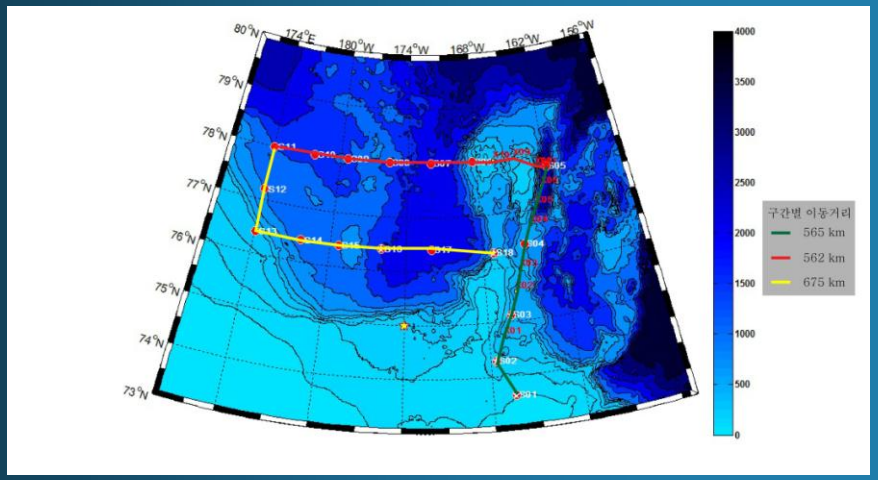
St	number	Depth (m)	width*length (m^2)	T (℃)	S (psu)	Chl-a (mgm^{-3})	pH	PO_4 (uM)	NO_2+NO_3 (uM)	NH_4 (uM)	SiO_2 (uM)
Ice St.1	mp1	0.4~0.5	10*12	0.3	0.5	0.12	6.25	0.16	0.50	0.57	1.13
	mp2	0.4~0.5	12*12	0.9	25.3	0.07	7.57	0.35	0.29	0.64	1.77
	mp3	0.4~0.5	8*8	0.9	23.8	0.16	7.61	0.39	0.29	0.50	2.03
	mp4	0.4~0.5	3*3	-1.1	13.5	0.14	7.35	0.19	0.57	0.57	1.07
	mp5	0.4~0.5	1.5*1.5	-0.9	17.4	0.06	6.18	0.03	0.43	0.50	0.23
	mp6	0.4~0.5	10*10	-1	2.7	0.15	6.43	0.06	0.29	0.57	1.28
Ice St.2	mp1	0.4~0.5	8*2	0.8	0	0.16	6.09	0.03	0.00	0.36	0.05
	mp2	0.4~0.5	10*8	-1.1	28.3	1.28	7.62	0.52	0.07	0.64	
	mp3	0.4~0.5	5*4	0.6	0.6	0.48	6.28	0.06	0.00	0.43	0.12
	mp4	0.4~0.5	20*10	-1.3	22.4	0.16	7.98	0.10	0.00	0.43	0.55



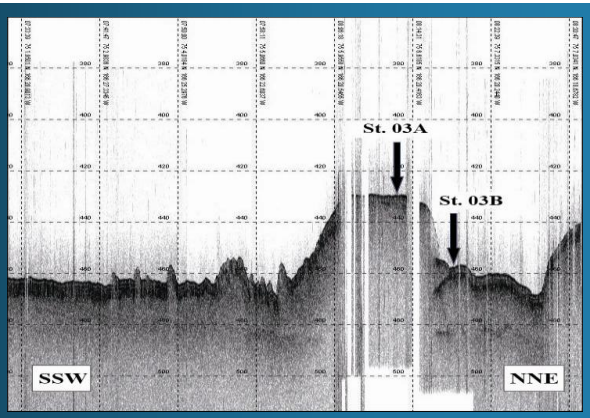
Paleoceanography

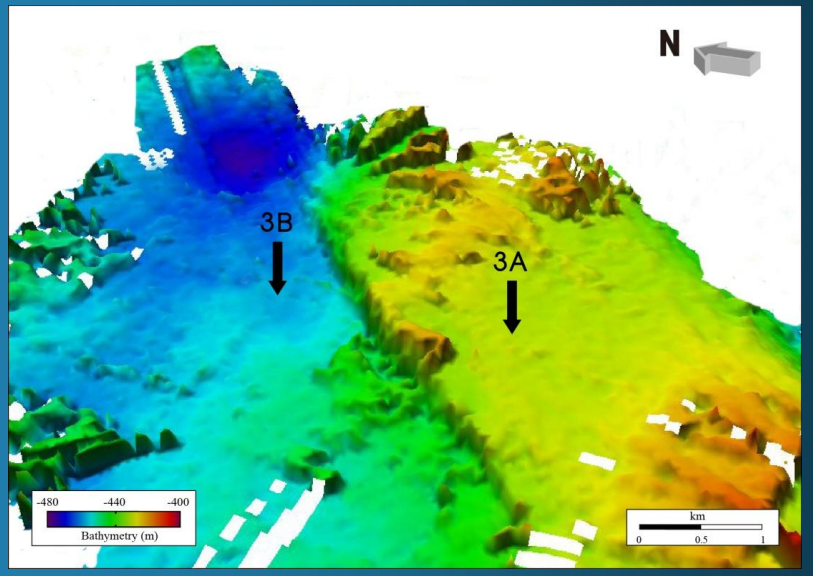
Seung-Il Nam: sinam@kopri.re.kr

- **Reconstruction glacial history and paleoceanographic changes (sea-ice coverage, brine formation, paleoproductivity, origin of organic matters, etc.) in the western Arctic Ocean during late Quaternary glacial-interglacial cycles.**

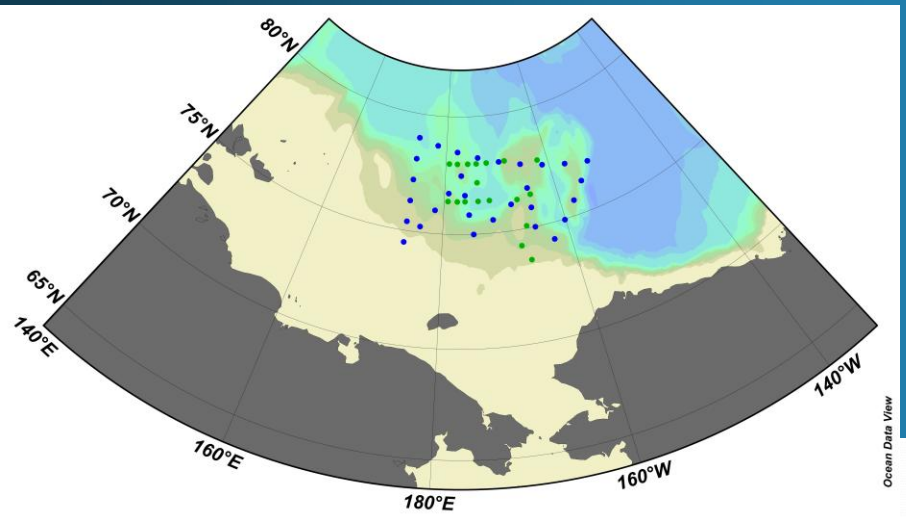


- **ca. 2,000** km seismic survey: Acquisition of multi-beam & SBP (Sub-bottom profiler)
- ca. 3.2 m sediment cores from 9 geological stations
- 15 box & multiple sediment cores at 15 stations



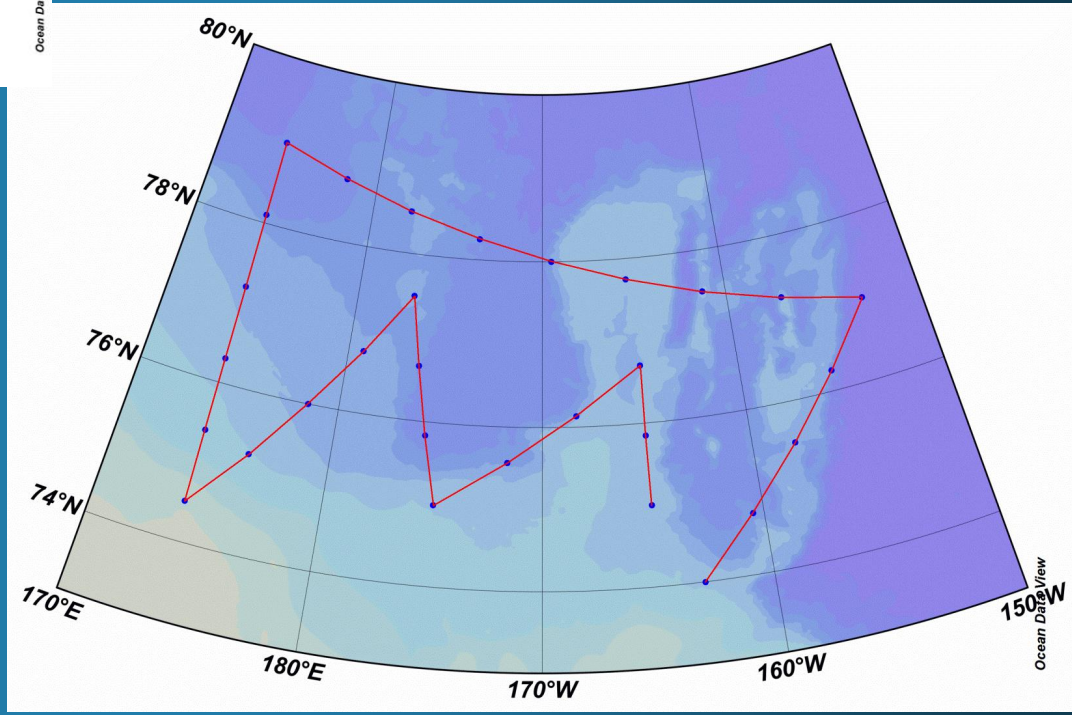


2012 Plan (Tentative)



- **Period**: 2011. 07.31 ~ 09.08 (Nome to Nome)
- **Participants**: not fixed

- **Research field:**
  - Atmospheric observation
  - Satellite remote sensing
  - PCO_2 measurement
  - Hydrographic survey
  - Microbes & Plankton ecology
  - Sea ice study
  - Melt pond (ice algae) study
  - Paleoceanography



Plankton Ecology

Dr. Eun Jin Yang: ejyang@kopri.re.kr

Protozoan community structure, diversity and production

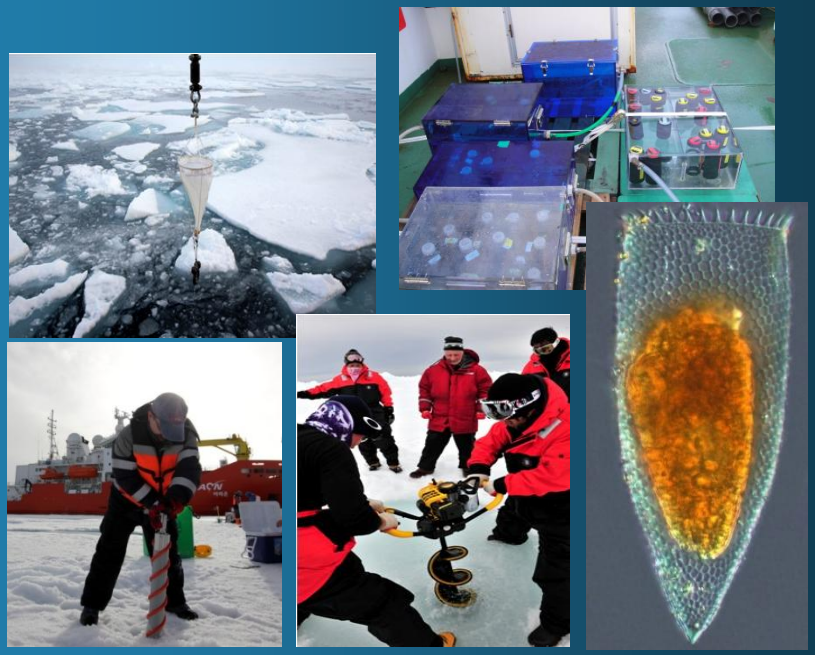
- **Objectives :**

  To investigate the ecological characteristic of protozoa in relation to physical environmental conditions (e.g. water mass and sea ice)

  - Distribution and community structure
  - Protozoan indicater species for detect environmental variation
  - Herbivory of protozoan grazers

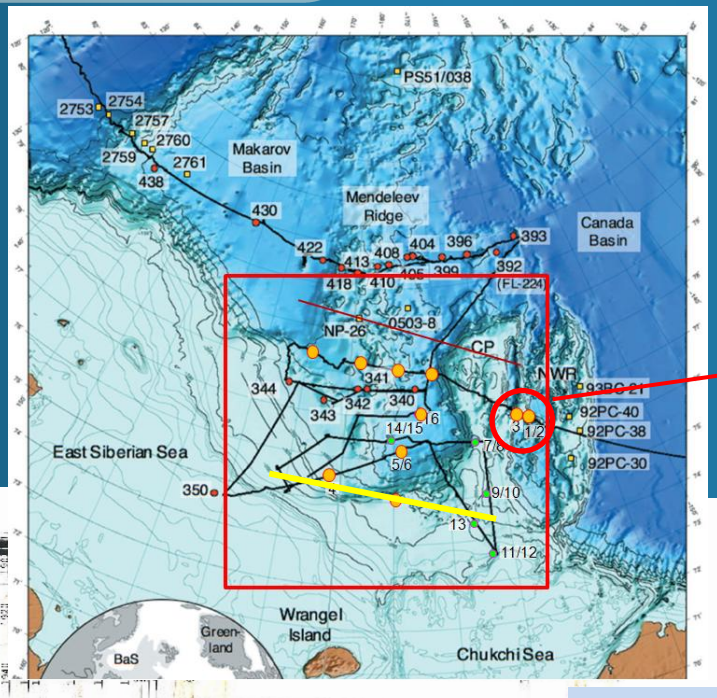
- **Work plan :**

  - depth sample by CTD rosette sampler
  - vertical plankton net (20um)
  - Ice core
  - water sample from underwater sea-ice
  - deck incubation for protozoan herbivory

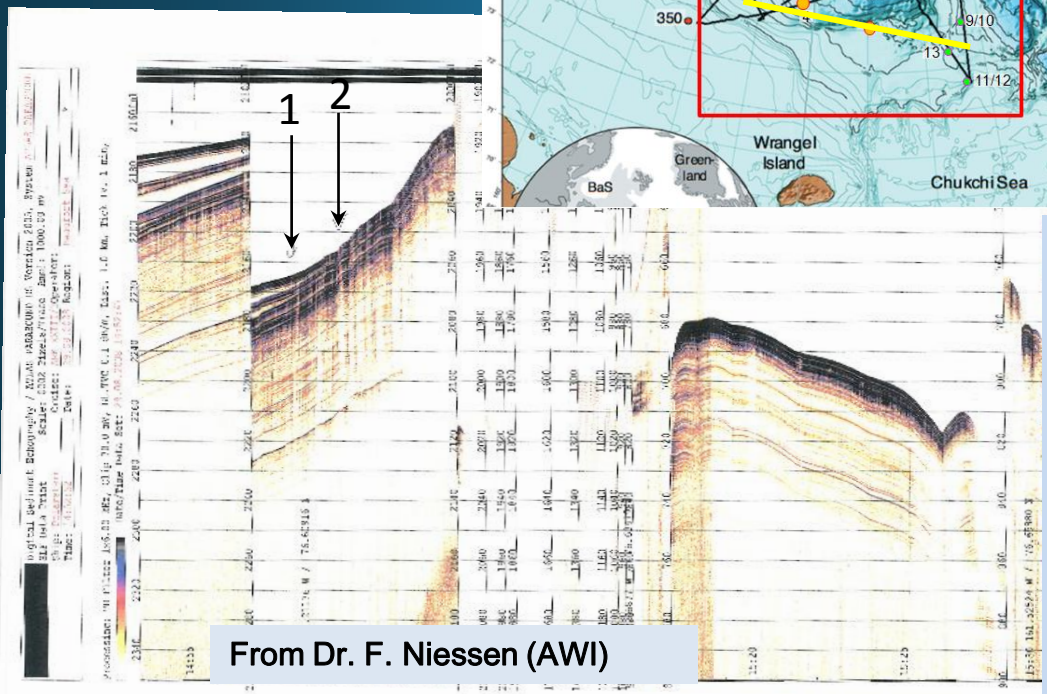


Paleoceanography

Seung-Il Nam: sinam@kopri.re.kr



Stations 1/2



From Dr. F. Niessen (AWI)

- **ca. 3,000** km seismic survey:
  Acquisition of multi-beam & SBP (Sub-bottom profiler) including Yellow line for AWI
  & Byrd Polar Research Center (IODP new proposal)
- ca. 50 m sediment cores from 12 geological stations
- 20 box & multiple sediment cores at 20 stations

Thank You