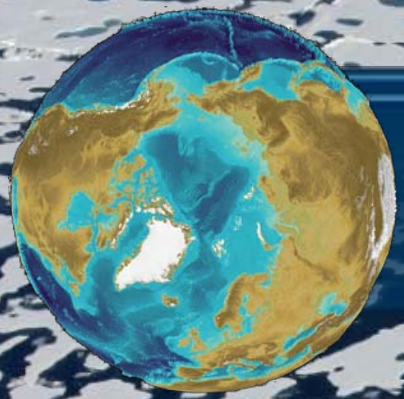
Korea Arctic Ocean Research

10. Dec. 2010

Kyung Ho Chung, Korea Polar Research Institute

KOPRI

2010 Cruise Operation



Objectives

- To detect any changes in marine ecosystem under current climate changes in the Arctic Ocean
- To monitor marine ecosystem responding to ongoing climate changes in the Arctic Ocean

Cruise Route

Participants (45)

(Korea: 34)
- Korea polar Research Institute: 14
- Maritime & Ocean Engineering Research Institute: 3
- Korea Institute of Machinery and Materials: 2
- Korea Meteorological Administration: 2
- Korea Hydrographic & Oceanographic Administration: 1
- Korea Maritime Univ. : 7
- Seoul National Univ. : 1
- Inha Univ. : 1
- Hanyang Univ.: 1
- Medical doctor: 1

(Foreign Country : 11)
- Scottish Association for Marine Science, UK: 1
- Chinese Arctic & Antarctic Administration: 1
- Polar Research Institute of China: 1
- The 3rd Institute of Oceanography, China: 1
- Philippine Univ.: 1
- Arctic & Antarctic Research Institute of Roshydromet, Russia : 2 (ice pilot & navigator)
- Maritime Helicopter, US: 3
- PBMS, US: Bear watcher 1

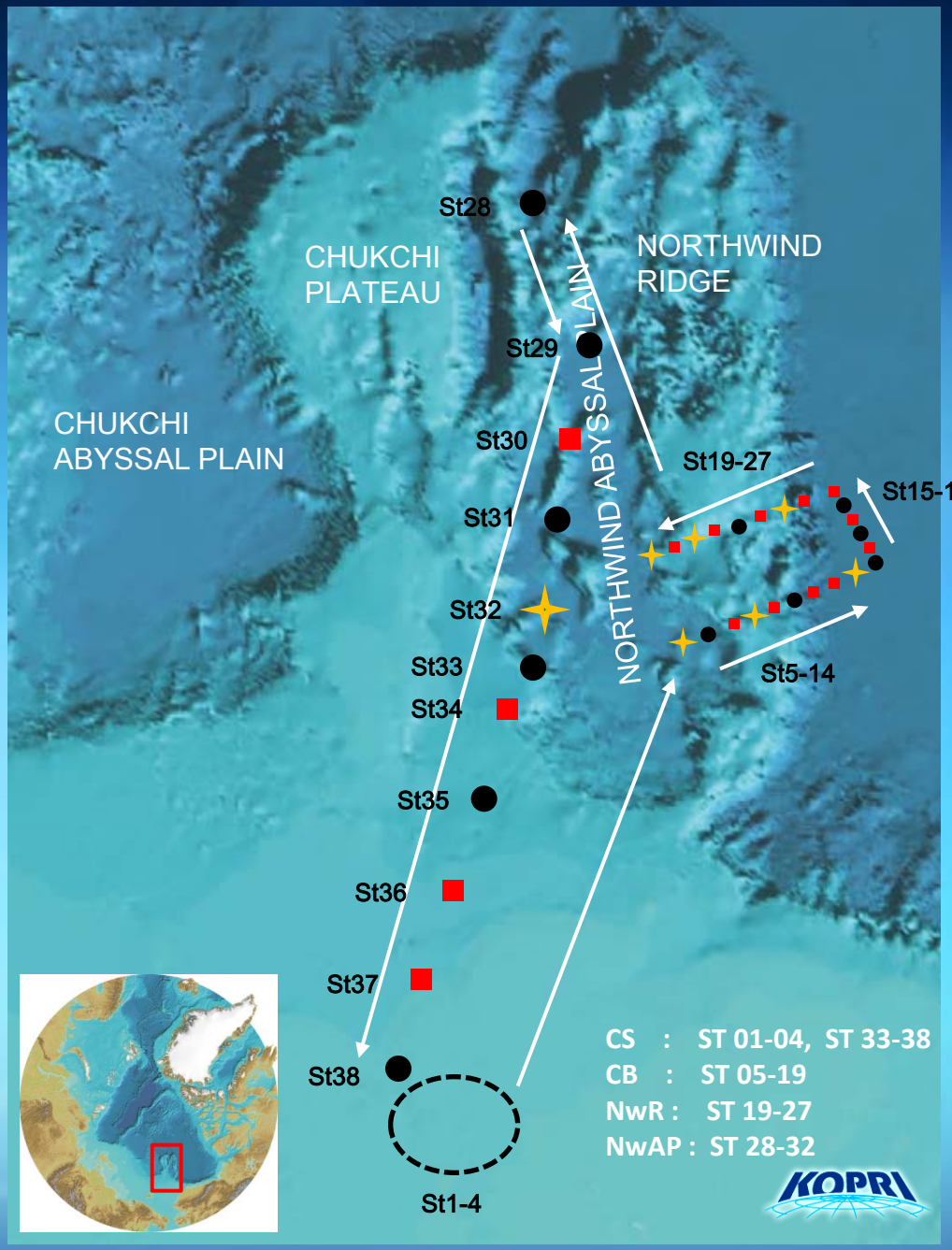
Study Area

Total 38 stations

- CTD, Bongo
- CTD, Water sample, Net
- CTD, Water sample, Net, Box/Multi core





Research Theme

Ocean

1. Blogeochemical cycles of bio-gas

- Inorganic carbon system of water column
- CO_2 flux between the seawater and the atmospheres
- Sea ice melt-water input

2. Microbial diversity & community structure

- 16S rRNA gene sequence of bacterioplankton
- 16S rDNA gene sequence of bacterioplankton
- Influences of various environmental parameters on the community structure

3. Diversity and biogeography of diatoms

- Collection & Isolation of diatoms
- Morphology and 16S rDNA gene sequence

Research Theme

Ocean

4. Phytoplankton ecology & physiology

- Pigments, biomass and species composition
- Carbon & nitrogen uptake rate
- Physiological status, nutritional condition, and bio-optical properties

5. Heterotrophic protozoan community structure, grazing impact

- Protozoan abundance & diversity
- Role of protozoa as herbivores

6. Population dynamics and trophic role of zooplankton

- Collection of Copepods
- Morphology and lipid marker

Research Theme

Ocean

7. Glacial history & paleoceanographic changes

- Reconstruction glacial history and paleoceanographic changes during the last 60 ka
- Chronostratigraphy during the late Quaternary
- Characteristics & origin of organic matters in deposited marine sediment

Research Theme

Ocean

Continuously sampling area: Nome – Study area - Nome

Sampling parameters

Phytoplankton pigments (HPLC samples)

In vivo chlorophyll a, Temperature, Salinity

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

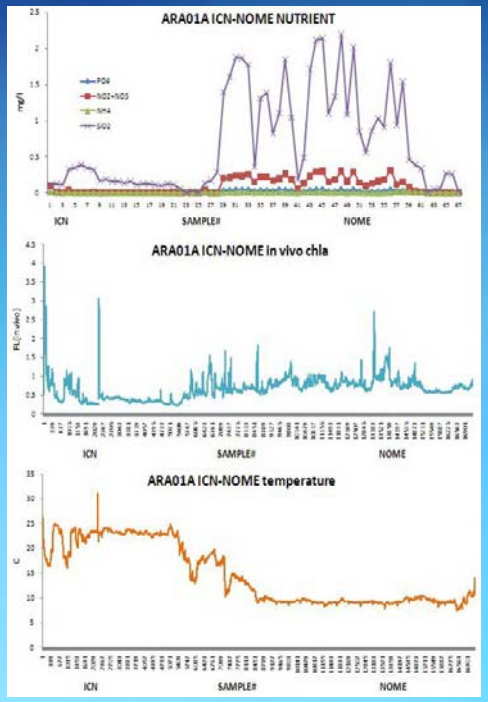
Physiological parameters (Fv/Fm, σPSII , 1/τPSII)

Air-sea fluxes of trace gases, CO_2, CH_4, N_2O, CO, H_2 and other sulfur compounds

How many?

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

Pigment & nutrient: every 4 hours



Underway sampling result

FIRe (Rutgers Univ.)

10-AU fluorometer

Nutrient AA

Research Theme

Sea Ice

- Sea ice thickness & snow depth
- Sea ice temperature & salinity
- Temperature, salinity, nutrient, phytoplankton biomass, diversity, chl-*a*, pigment, primary production of melting pond and under sea-ice layer






International cooperation with SAMS, UK

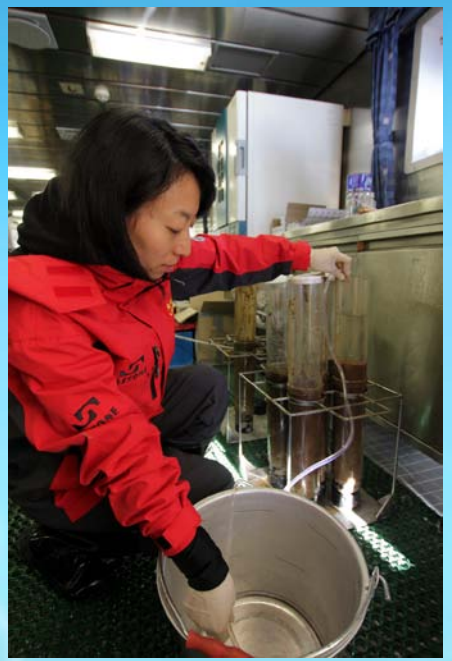
- A case project of combining satellite remote sensing with sea ice mass balance study
  - SAMS ice buoy(3) and CRREL ice buoy(1) deployment
  - EM31-SH calibration and survey

International cooperation with US

- SVP2(60m thermistor) Buoy deployment (Mike Steele, University of Washington)
  - Date & Time: 01:40, 27/July/2010(UTC), 00:20 09/August/2010(UTC)
  - Lat/Lon: 75 00 .03'N/ 159 01.95'W, 75 N/165W

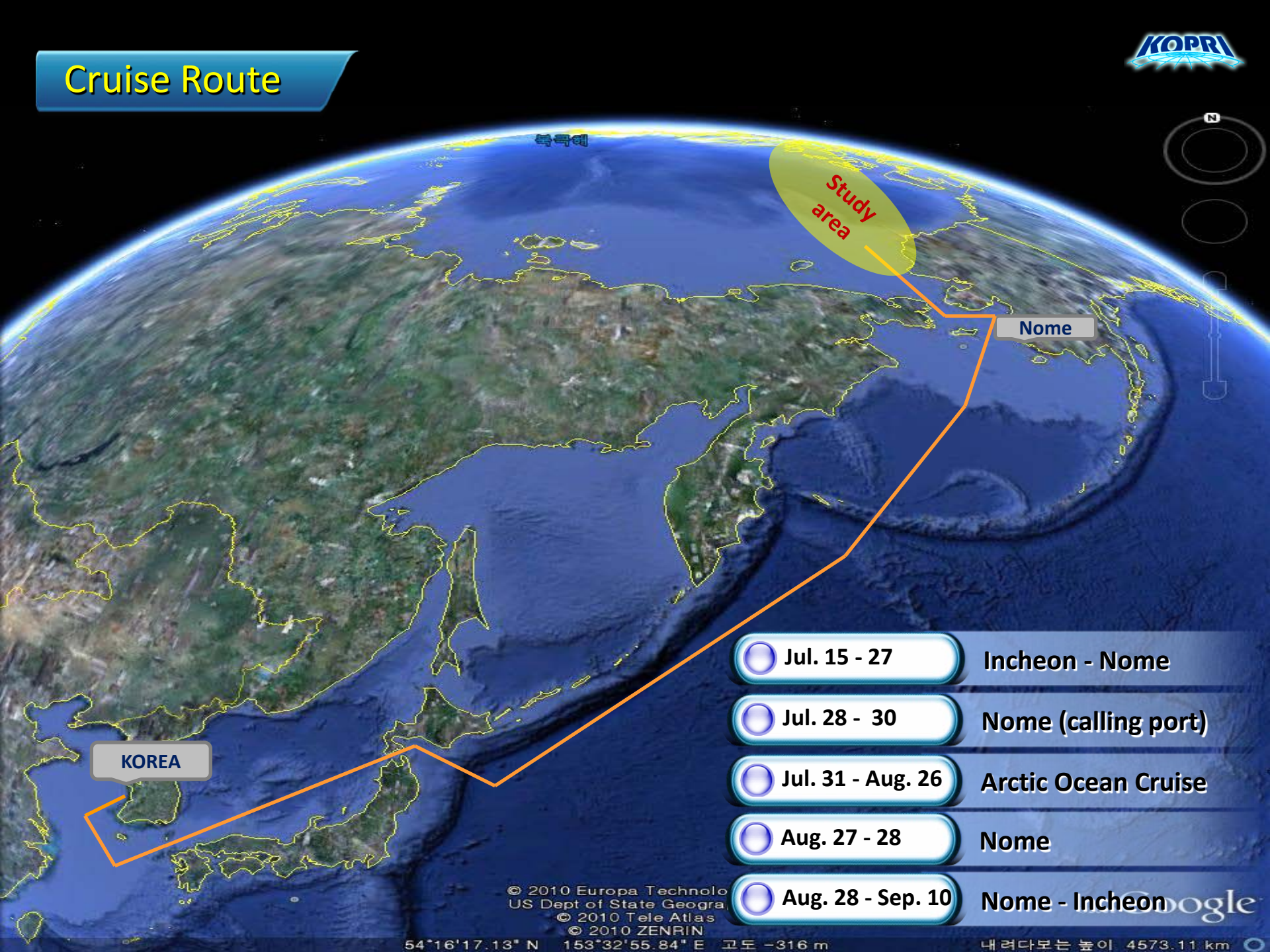
International cooperation with China

- Pollutants in seawater, sea-ice and marine sediment in the Arctic Ocean (Jiao Liping, 3rd Institute of Oceanography)
- Bacterial diversity in the Arctic Ocean (Yinxin Zeng, PRIC)
- Black carbon in the Arctic Ocean (Dou Tingfeng, CAA)

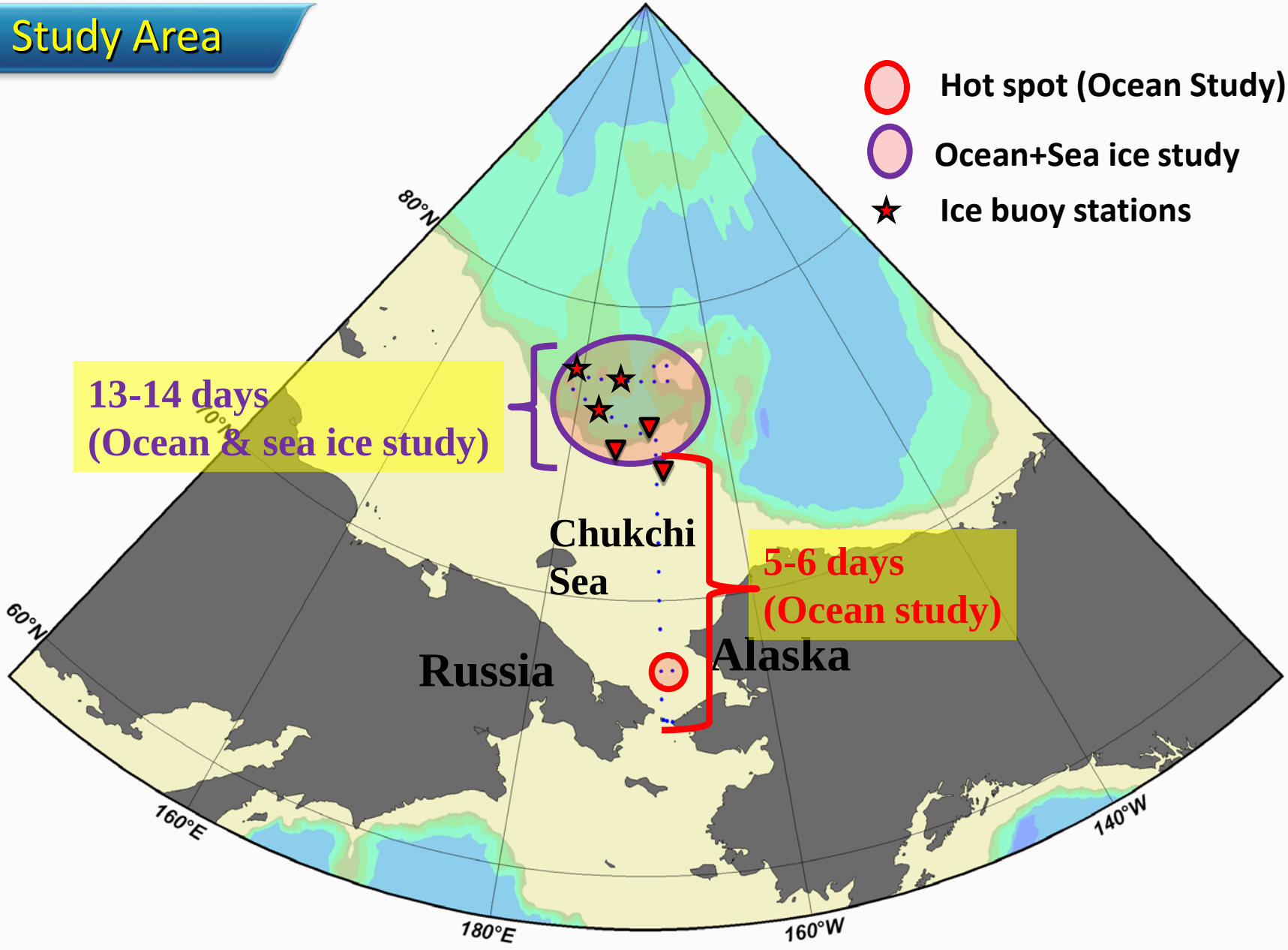


2011 Cruise Operation Plan (tentative)

Cruise Route



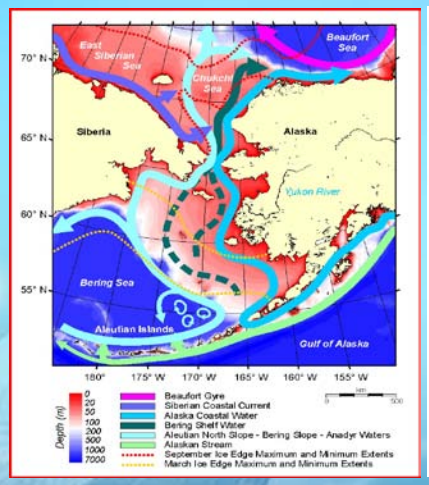
Study Area

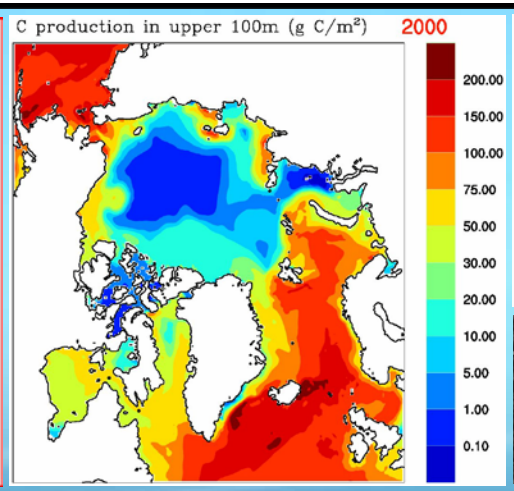

Hot spot (Ocean Study)
Ocean+Sea ice study
Ice buoy stations
13-14 days
(Ocean & sea ice study)
5-6 days
(Ocean study)
Chukchi
Sea
Russia
Alaska
80°N
70°N
60°N
160°E
180°E
160°W
140°W
Ocean Data View

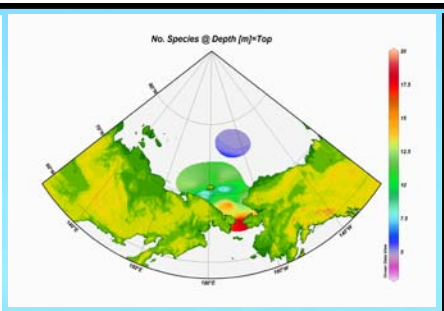
Research Theme

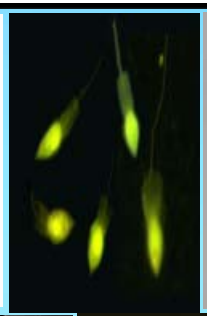
Ocean

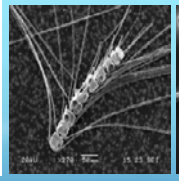
- Thermohaline structure of water masses (T, S) and transport pattern (velocity profile)
- Nutrients dynamics and reservoirs
- Diversity and biogeography of diatoms
- Structural plankton communities, bio-optics and physiological variability
- Variation of carbon and nitrogen uptakes and species composition of phytoplankton and ice algae
- Protozoan community & grazing impact

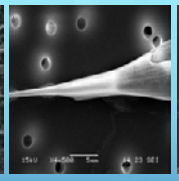


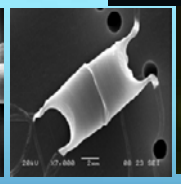


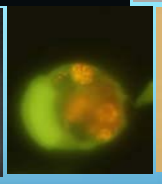


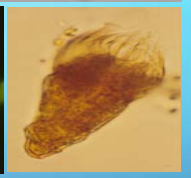












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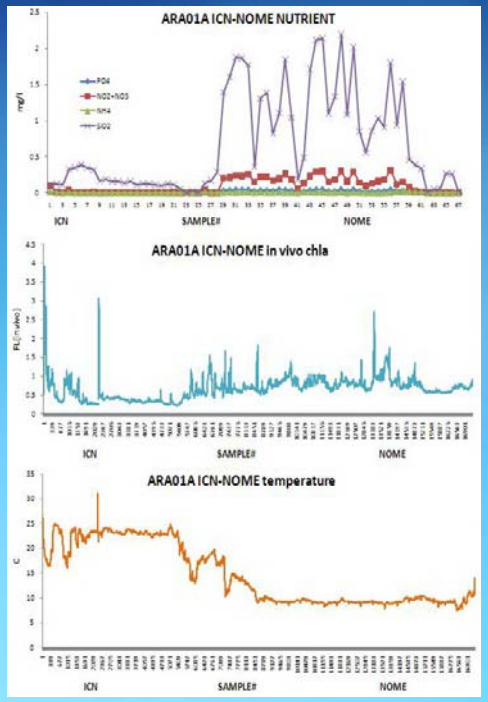

Underway sampling result

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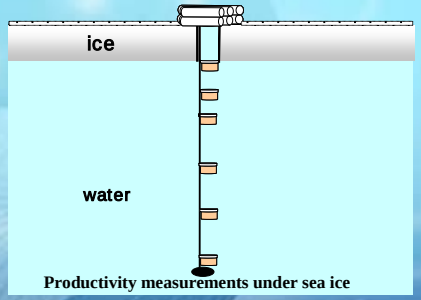
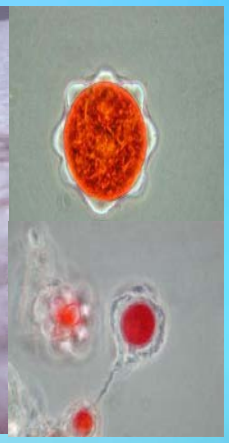
Research theme

Sea Ice

- Sea ice physical properties (thickness & density)
- Salinity, temperature and nutrients distribution in sea ice
- Light intensity measurements under sea ice
- C/N productions and photosynthetic products of ice algae and phytoplankton under sea ice
- Species compositions of phytoplankton, ice algae, and cryosphere animals
- Melting pond ecosystem study





International cooperation with SAMS

Phil Hwang (PI), Jeremy Wilkinson and Keith Jackson
The Scottish Association for Marine Science

We propose to deploy one automated weather station and 6 Sea Ice Mass Balance Array (SIMBA) at different ice features: hummock, melt pond, level ice and ridge. The purpose of this work is to investigate the thermodynamic processes (melt/growth rates) between different ice features.

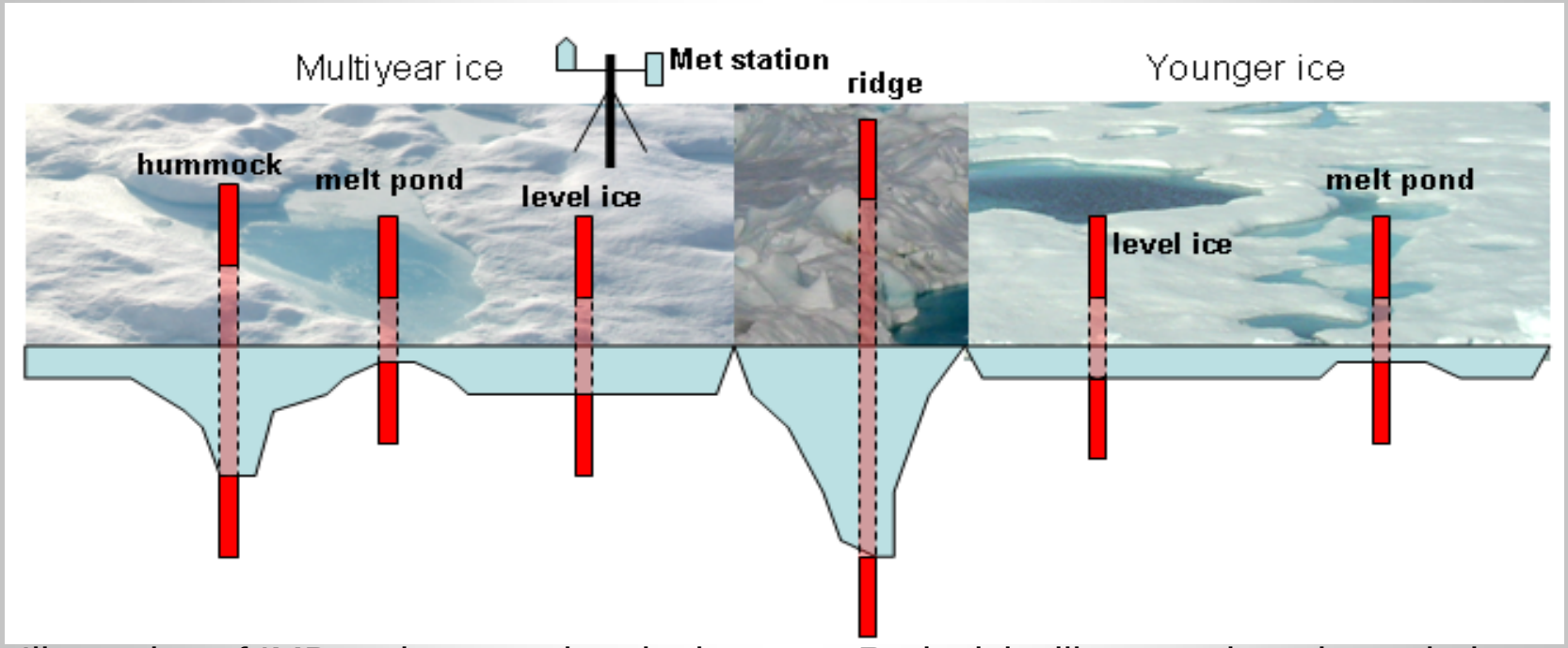


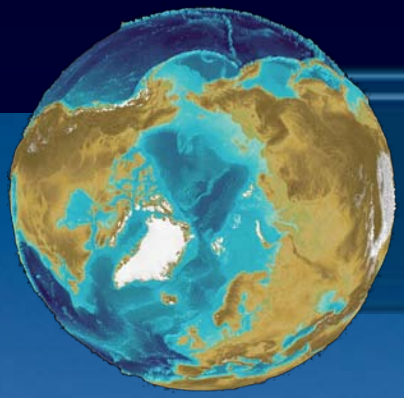
Illustration of IMB and met station deployment. Red sticks illustrate thermistor chains.

2 Helicopter Operation

Bell 206 Long Ranger

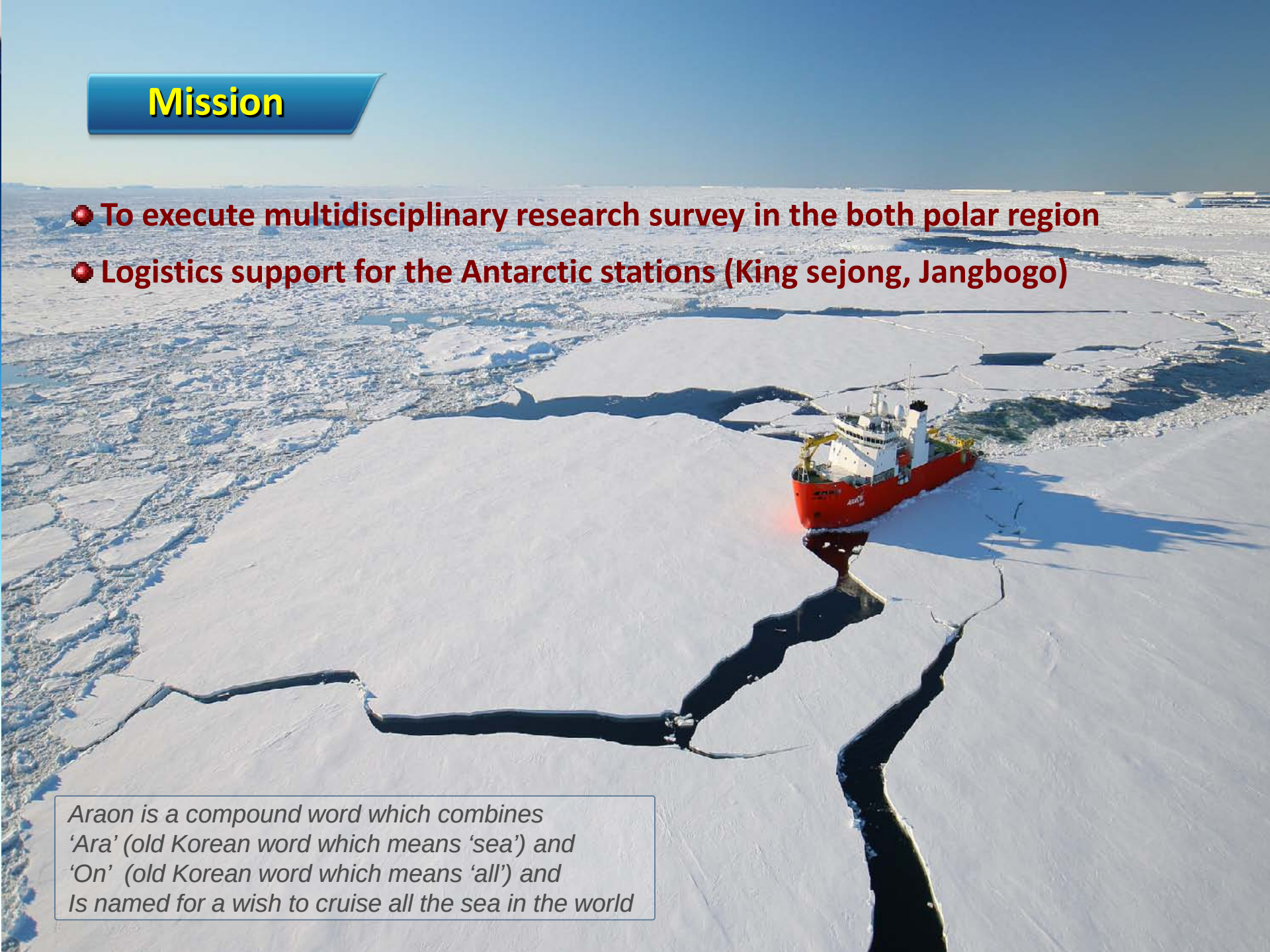
Bell 206 Jet Ranger

Korean Research Icebreaker *ARAON*



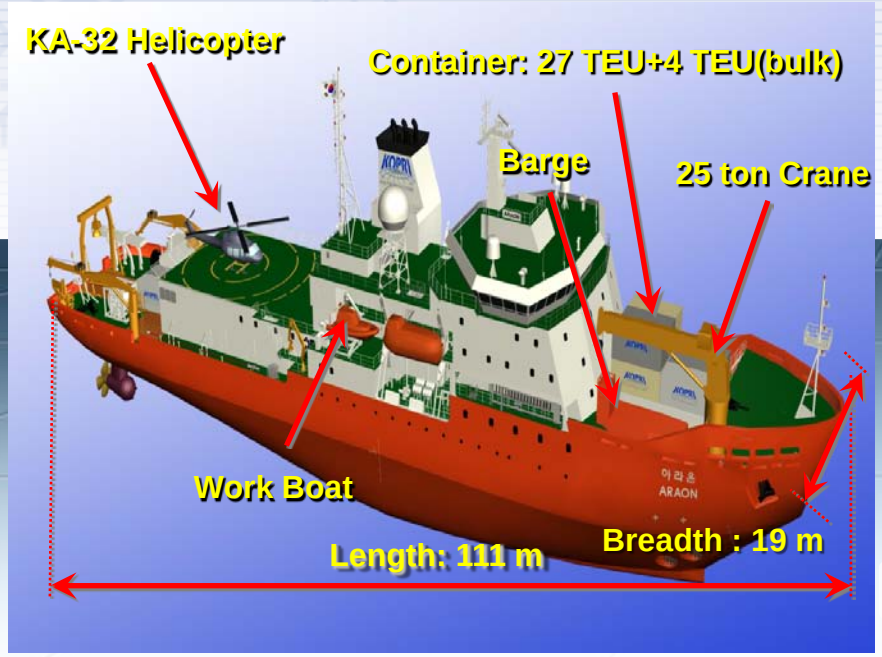
Mission

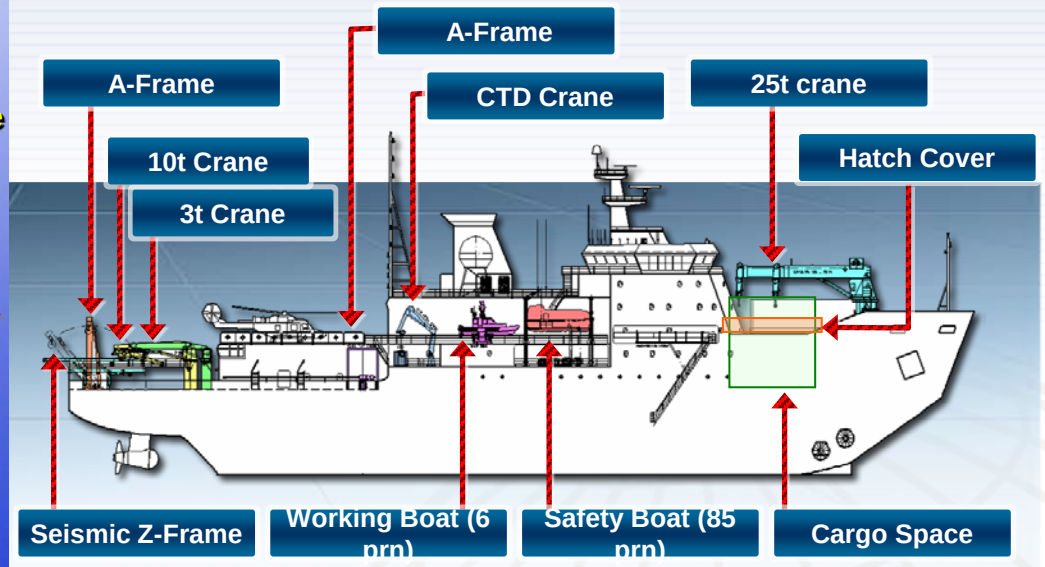
- To execute multidisciplinary research survey in the both polar region
- Logistics support for the Antarctic stations (King sejong, Jangbogo)



Araon is a compound word which combines
'Ara' (old Korean word which means 'sea') and
'On' (old Korean word which means 'all') and
Is named for a wish to cruise all the sea in the world

General description





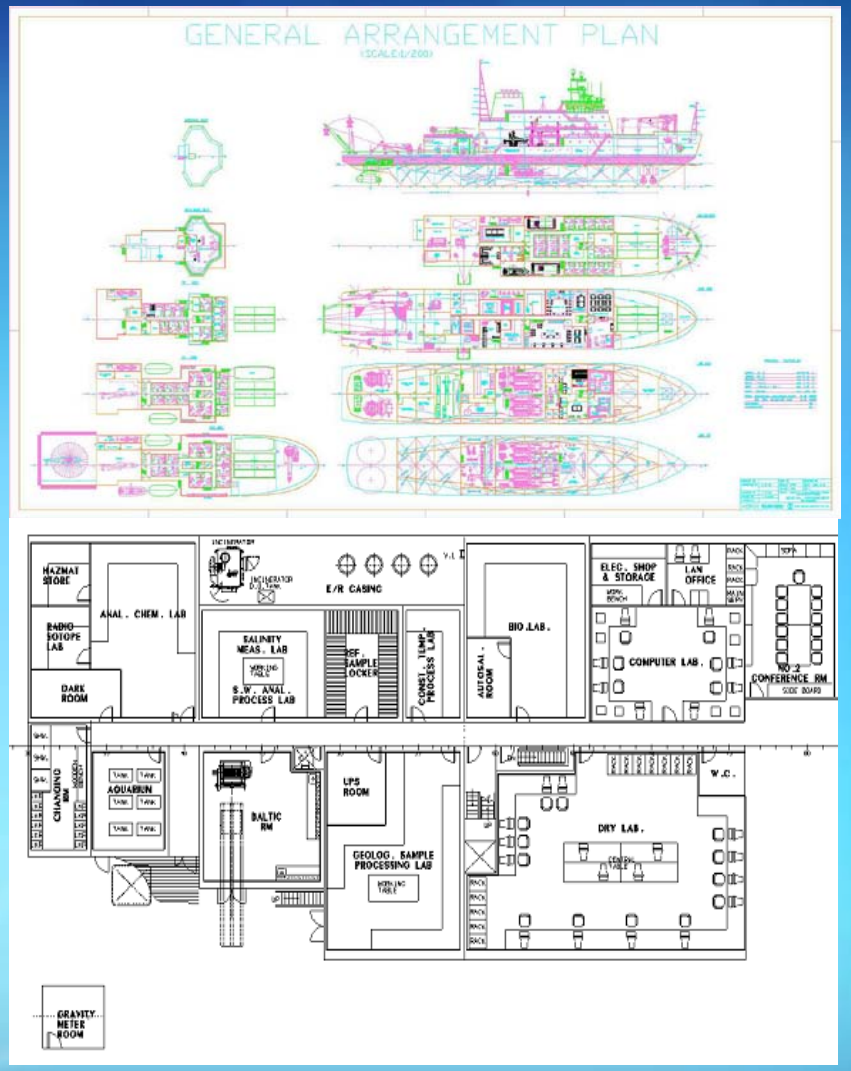
- **Dimension:** L(110.0m) x B(19.0m) x H(9.9m)
- **Ship Type:** KR (=DnV) PL10
  (1m thick icebreaking in 3 knot)
- **Gross Tonnage:** 7,487 tones
- **Accommodation:** 85 persons
  (25 crews + 60 researchers)
- **Service Speed:** 12 knots(max.16)
- **Endurance:** 70 days(20,000 nm)
- **Cargo:** 31 TEU of 20ft container
- **Propulsion:** 2 Azimuth thruster(main)
  2 tunnel thruster

KOPRI 극지연구소

Laboratory Arrangement

◆ **Research Laboratories**

- Computer Lab.
- LAN Office
- Electronic Shop & Storage
- Autosal Room
- UPS Room
- Dry Lab.
- Geological Sample Processing Lab.
- Constant Temperature Processing Lab.
- Sea Water Analysis Processing Lab.
- Baltic Room
- Analytical Chemistry Lab.
- Hazardous Material Store
- Radioisotope Lab.
- Dark Room
- Aquarium
- Gravity Meter Room



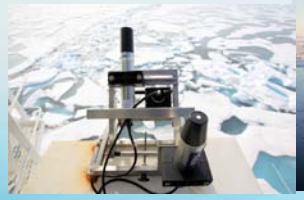
Equipments

- **Oceanographic Research**
  - CTD/Water Sampler (Niskin bottles), X-BT, Thermo-Salinograph, etc.
- **Acoustic Research**
  - Multi-Beam Echo Sounder, ADCP, Deep Tow Side Scan Sonar, Acoustic synchronizer etc.
- **Geophysics Research**
  - Multichannel Seismic System, Sub-Bottom Profiler, Marine Gravity Meter, Magneto Meter, etc.
- **Marine/Biological Research**
  - Mockness, Net Sonde, Bongo Net, RMT, Sea Soar etc.
- **Observation & Monitoring Equipment**
  - Weather Station, Weather Satellite Receiver, Underway Measurement System, Wave Meter, etc.
- **Etc.**
  - Marine Data Management System, Underwater Positioning System, etc.





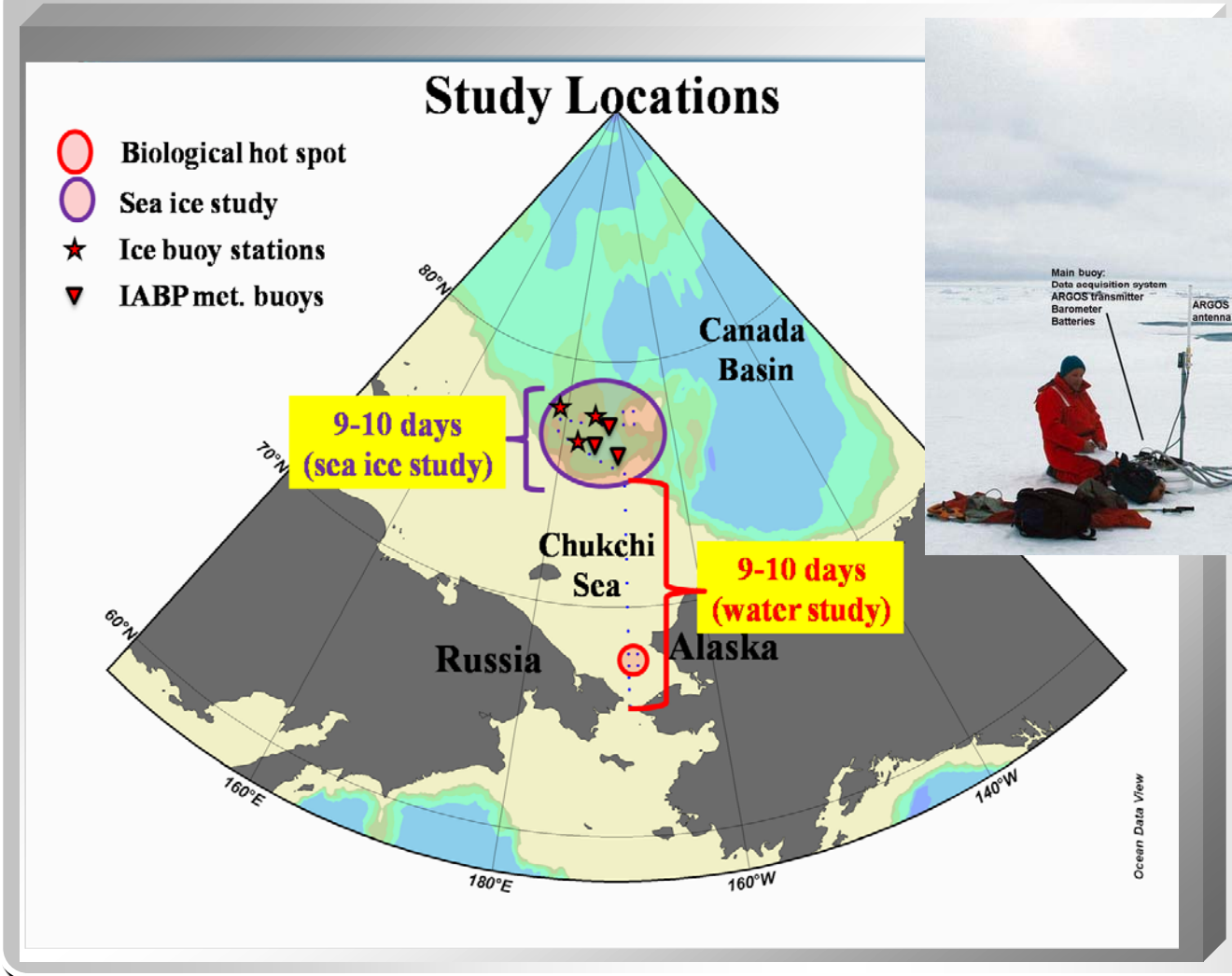


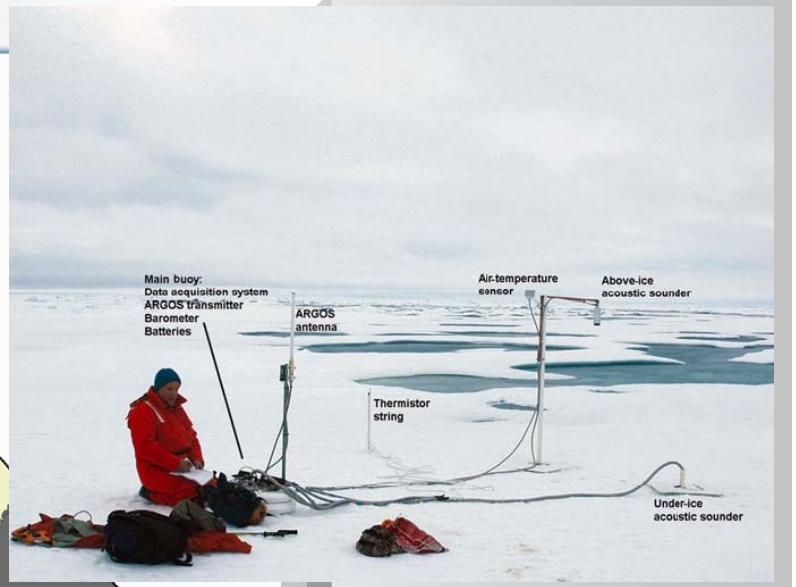





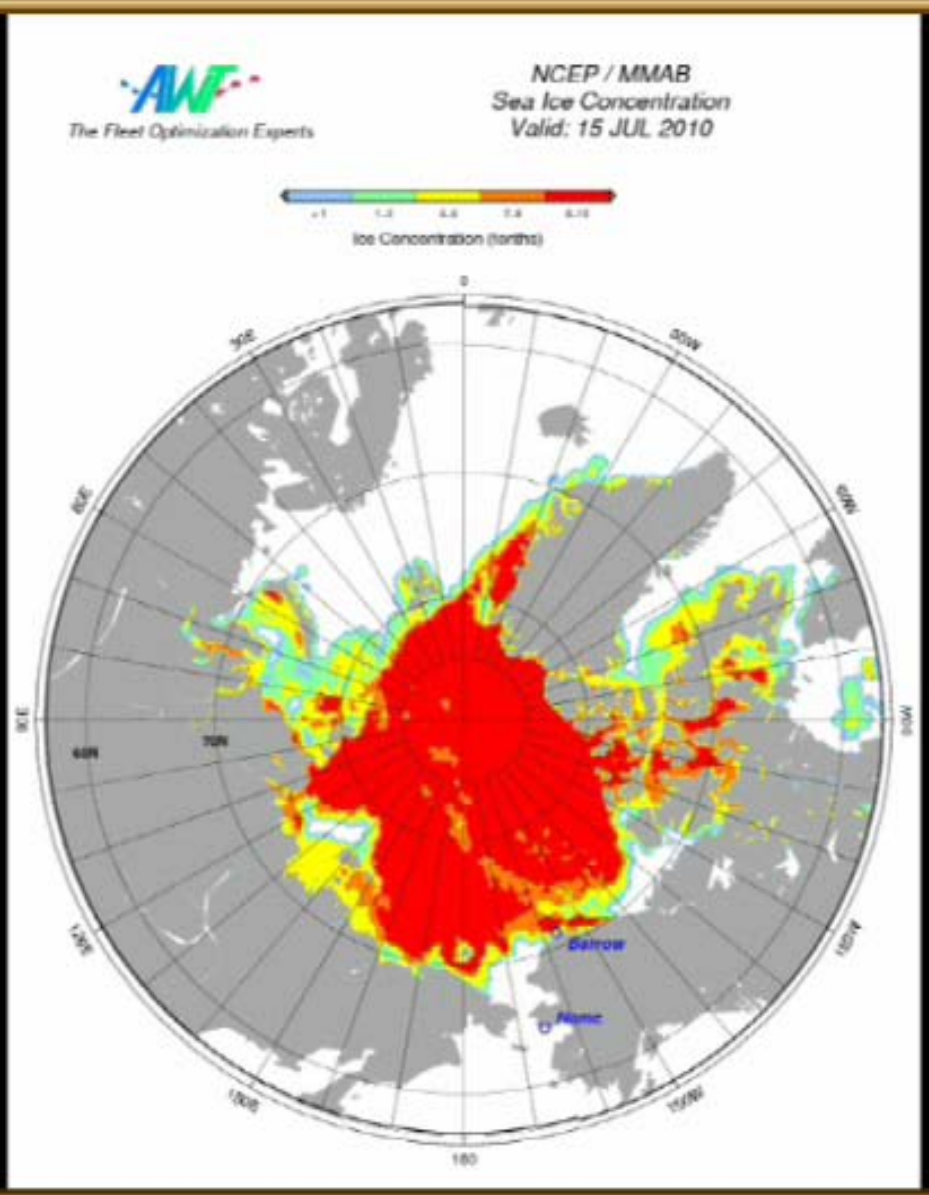
Thank You

International cooperation with NOAA





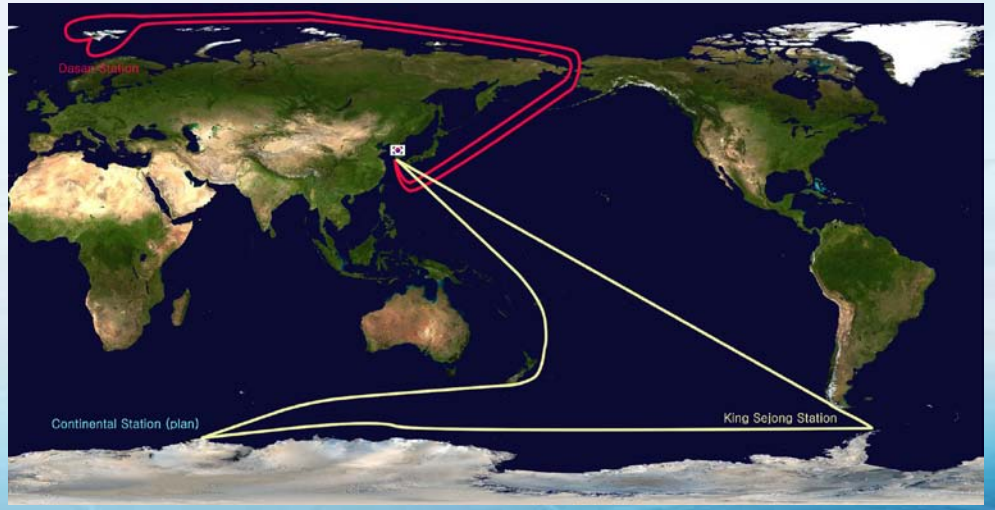
Sea ice distribution



Annual Operation Plan

- Nov. ~ Apr. : Antarctic expedition (including logistics support)
- May : Anchoring in Incheon
  (docking and maintenance, cargo loading, etc.)
- Jun. ~ Aug. : Arctic expedition
- Sep. ~ Oct. : Anchoring in Incheon
  (maintenance, cargo loading, etc.)

• Research & Logistics	165 days
• Maintenance	28 days
• Voyage	110 days
• Total	303 days



Research Plans for IPY and Post IPY

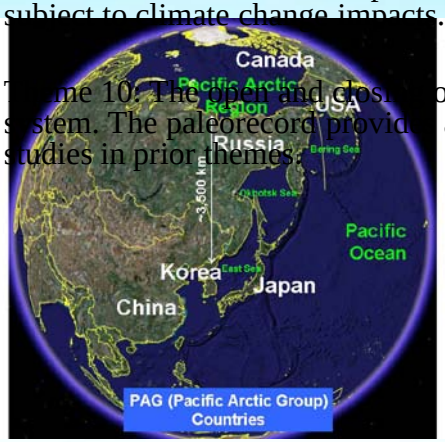
In order to understand the Arctic marine ecosystem response to ongoing environmental changes

- Nutrient Dynamics and Reservoirs
  (*In-situ* measurements and monitoring with ISUS)
- Variations of Carbon/Nitrogen Uptakes and species compositions of Phyto and Ice algae
  (*In-situ* measurements and remote sensing data)
- DOC Production
- Sinking Rates of POC to the Bottom Ocean
- Effects of increasing River Water Input
  (Terrestrial Organic Carbon, Contaminants)
- Organic Carbon Flux to Higher Trophic Levels
  (grazing rate, nutritional status, migration of zooplankton)

International Cooperations !!!

Research items for future plans (Pacific Arctic Group)

- Theme 1: Undertake seasonal and interannual ocean observations in the Pacific Arctic Sector where recent maximum sea ice retreat is occurring.
- Theme 2: Understanding oceanic and atmospheric processes in the Pacific Arctic, including the feedback loops, are critical to mid- and low-latitude climate variability.
- Theme 3: Monitoring fresh water input via precipitation, riverine input, oceanic input, glacial and sea ice melt in the Pacific Arctic sector will improve our understanding of mid-latitude climate variability and provide additional information to support theme 1.
- Theme 4: Identify and monitor ecosystem and biological indicators and chemical tracers (e.g., ice, water column, benthic, higher trophic organisms, isotopes and trace gases) of climate change in the Pacific Arctic.
- Theme 6: Understanding the connectivity of warm Atlantic inflow to the Pacific sector, heat flux throughout Arctic, and associated biodiversity/invasion of Atlantic-species into the region. Physical gateways should be mapped and monitored, including outflow through the Canadian Arctic Archipelago.
- Theme 5: Investigate sea ice thermodynamics including sea ice thickness, extent, and its interactions with ocean and atmospheric forcing in the Pacific Arctic region. Investigate sea ice dynamics such as sea ice drift, interactions between different ice packs.
- Theme 7: The Arctic Ocean is very poorly mapped from the seafloor to the ice above. Significant information gaps include the bathymetry, biodiversity, and knowledge of ocean currents and their variability over space and time. Exploration of the unknown Pacific Arctic region is essential for the construction of base maps necessary for the planning of future monitoring efforts.
- Theme 8: The Pacific water inflow through the Bering Strait region is a key conduit for heat, salt, nutrients, and biological material (including genetic material) to the Arctic basin that influences sea ice cover, halocline formation, and the carbon cycle.
- Theme 9: Nearshore coastal processes and subsea permafrost dynamics are important processes in the shallow Pacific shelf areas are subject to climate change impacts.
- Theme 10: The [illegible] of the [illegible] time periods with dramatic impact on the Arctic system. The paleorecord provid[illegible] a long[illegible] limatic processes relative to contemporary studies in prior themes.



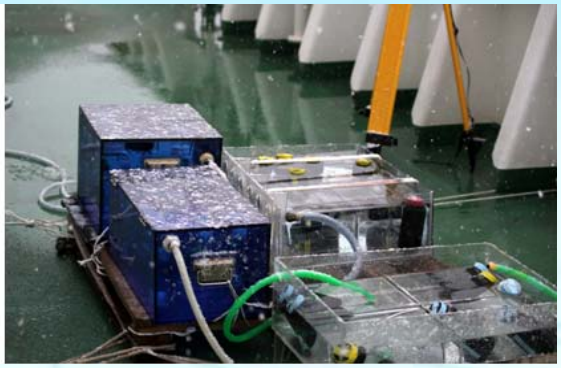
Heterotrophic protozoan community structure, grazing impacts and trophic interactions

- To improve understanding of specific feeding interactions and pathways of carbon flow in the pelagic food webs
  1. Protozoan abundance and diversity
  2. Comparison of the roles of copepod and protozo as herbivores

- Sampling

  : Water column (each depth), Sea Ice under water , Vertical net (20um), Deck incubation (48hr)

Vertical towing



Deck incubation

- Population dynamic and trophic role of zooplankton
- Target species : copepod
- Sampling : Bongo net (300um & 500um)
  MOCNESS (500um) -> depth sample
- Analysis : microscope, lipid marker using GC mass

Bongo net

MOCNESS

What we did on sea-ice in 2010

- Production, biomass and biodiversity of sea-ice community

- Study site : sea-ice and under-ice water layer
  4 point study during 2010 survey

- Analysis items
  ->chemical & physical items
  : ice thickness, snow depth, ice temperature, salinity, nutrients
  ->biological items
  : Primary production , chl-a, pigments, biomass of plankton, diversity