Korean Polar Research Programs

2013 Korea-Chile Workshop
on Science Collaborations

SangHoon Lee

2013 November

KOPRI

CONTENTS

The Function of KOPRI

- Research institute supported by the government
- Leading agency for national polar programs
- Entity since 1987

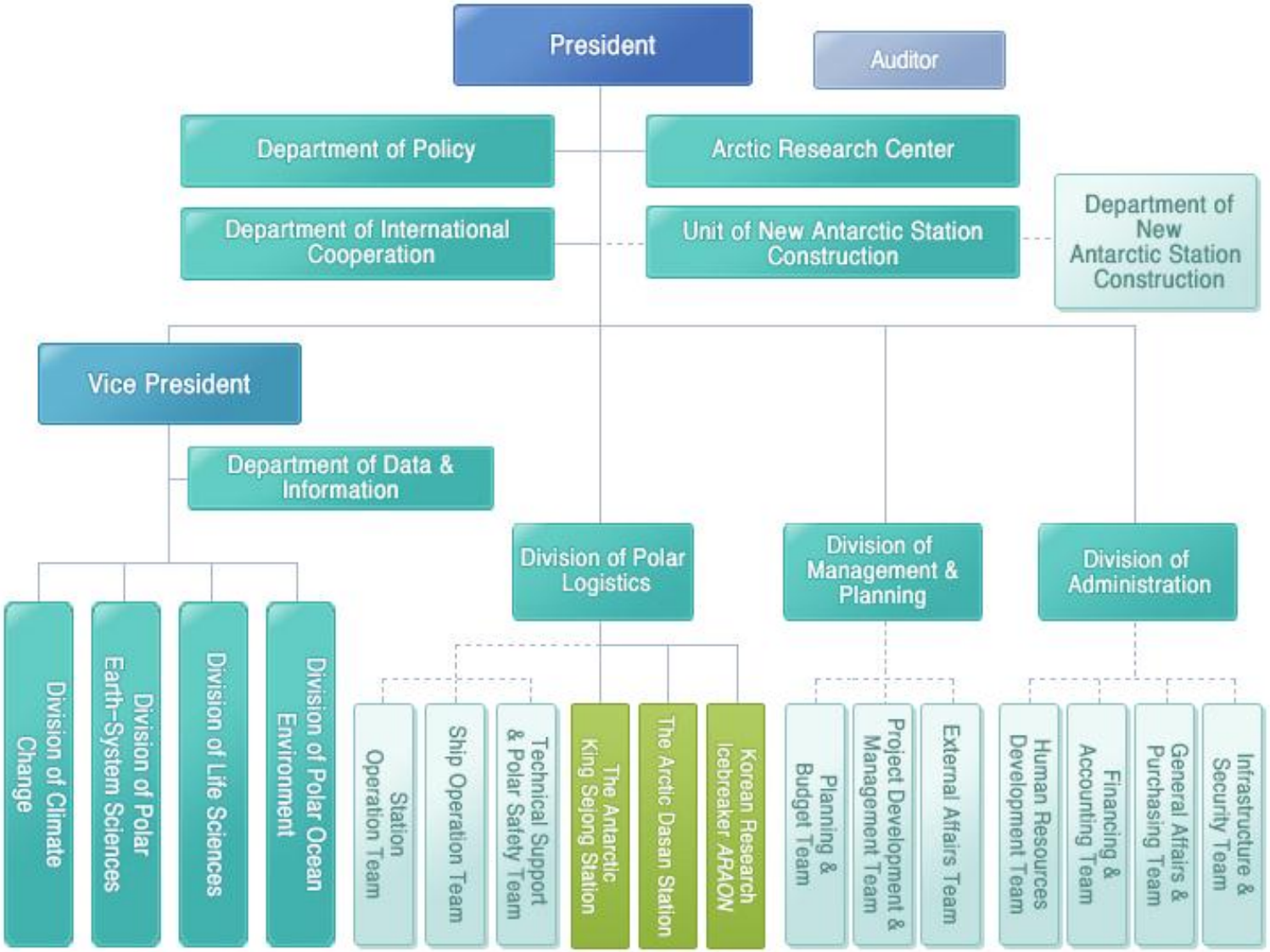
RESEARCH INSTITUTE → **SCIENCE**: Organize and conduct science research; Provide logistics for polar programs

NATIONAL OPERATOR

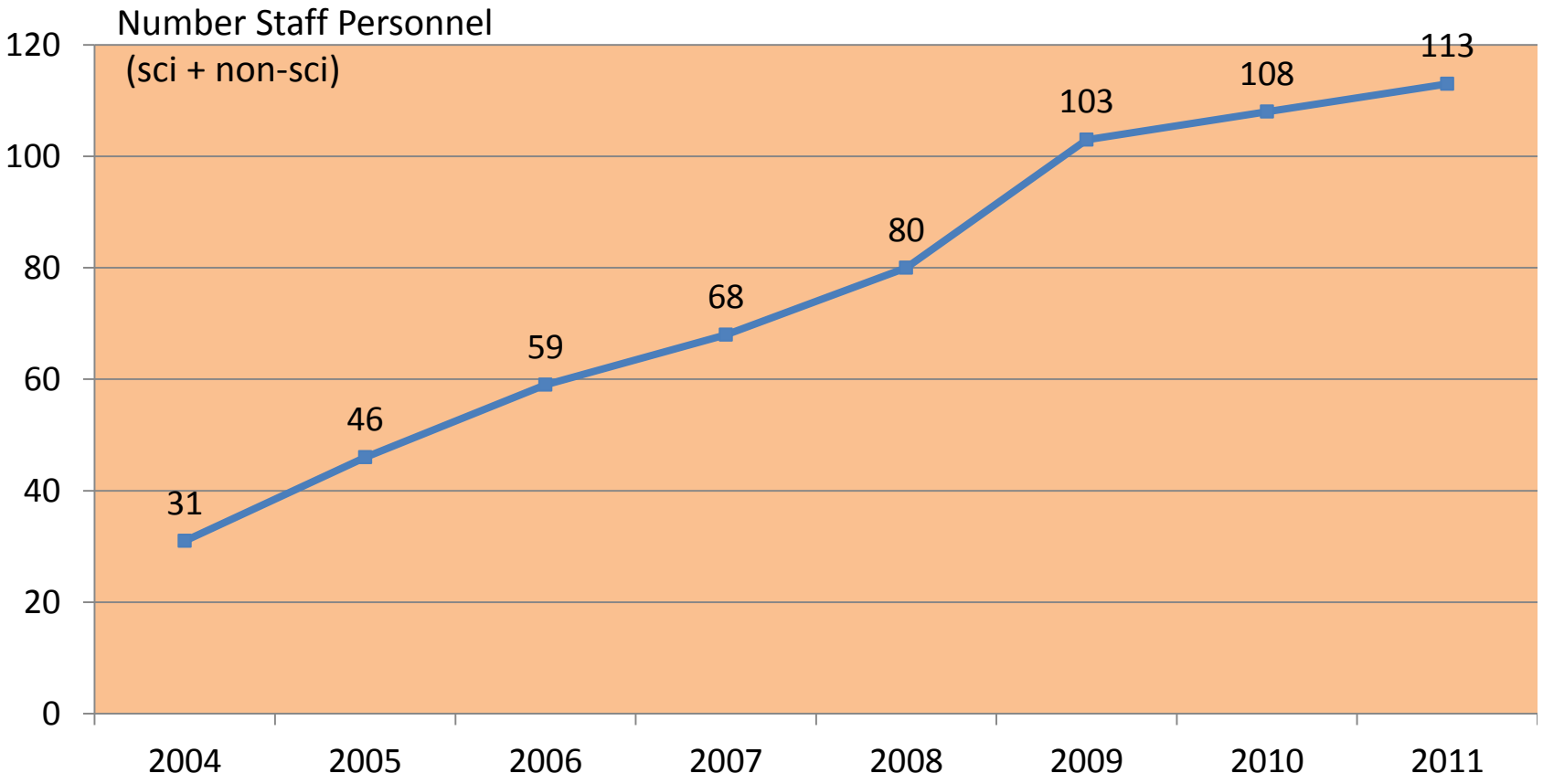
- → **PUBLIC & Domestic Networks**: Co-evolution with domestic joint programs; Education and public awareness
- → **INTER-NATIONAL**: Collaborate with foreign institutes & organization; Participate in international research programs
- → **GOVERN-MENT**: Provide expert advice in polar affairs

KOPRI

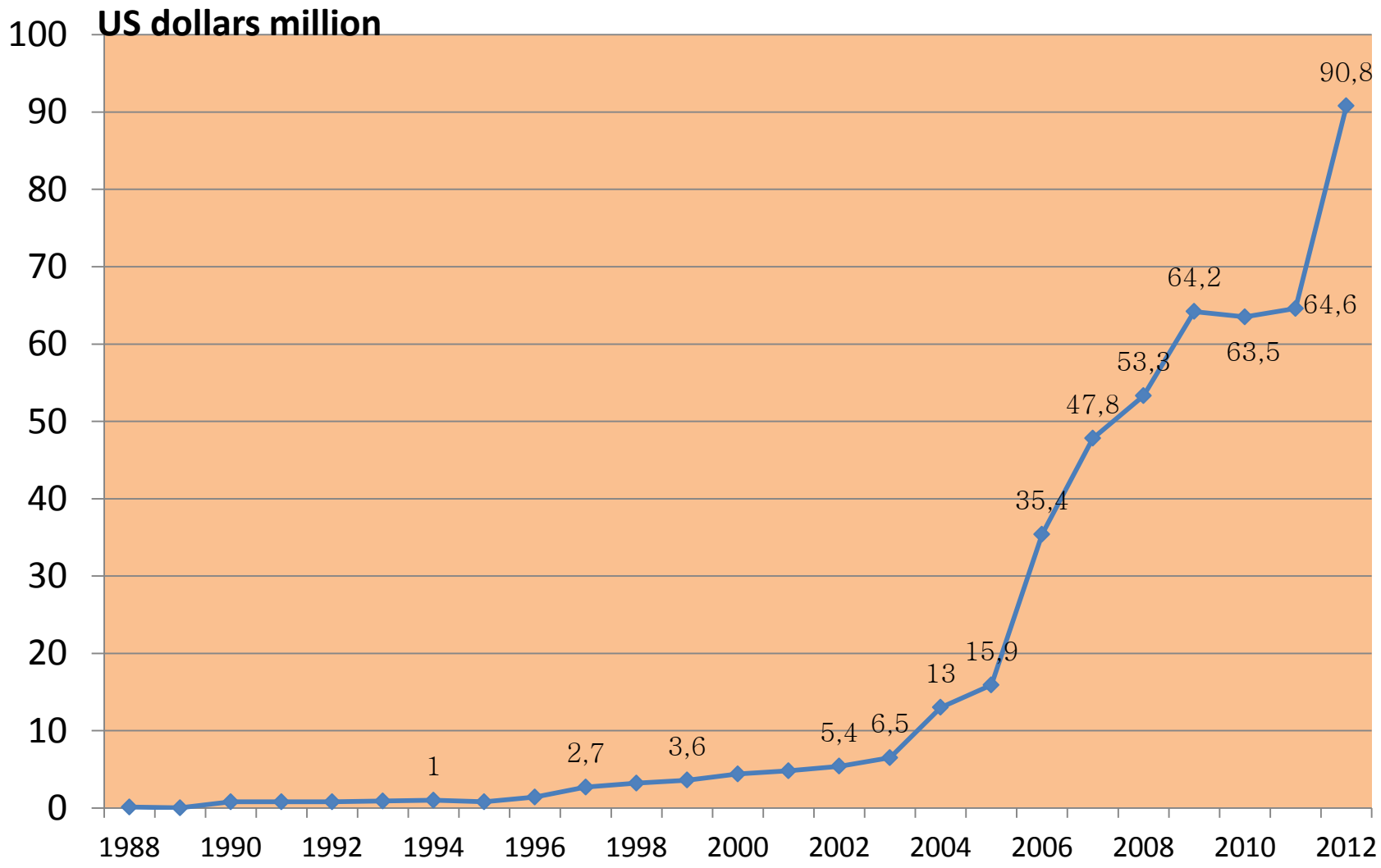
Structure


President
Auditor
Department of Policy
Arctic Research Center
Department of International Cooperation
Unit of New Antarctic Station Construction
Department of New Antarctic Station Construction
Vice President
Department of Data & Information
Division of Polar Logistics
Division of Management & Planning
Division of Administration
Division of Climate Change
Division of Polar Earth-System Sciences
Division of Life Sciences
Division of Polar Ocean Environment
Station Operation Team
Ship Operation Team
Technical Support & Polar Safety Team
The Antarctic King Sejong Station
The Arctic Dasan Station
Korean Research Icebreaker ARAON
Planning & Budget Team
Project Development & Management Team
External Affairs Team
Human Resources Development Team
Financing & Accounting Team
General Affairs & Purchasing Team
Infrastructure & Security Team

Manpower


Number Staff Personnel
(sci + non-sci)
120
100
80
60
40
20
0
31
46
59
68
80
103
108
113
2004
2005
2006
2007
2008
2009
2010
2011

Budget Increase since 1988



Polar Infrastructure at KOPRI

Dasan Station (2002)

Icebreaker ARAON (2009)

KOPRI (2013)

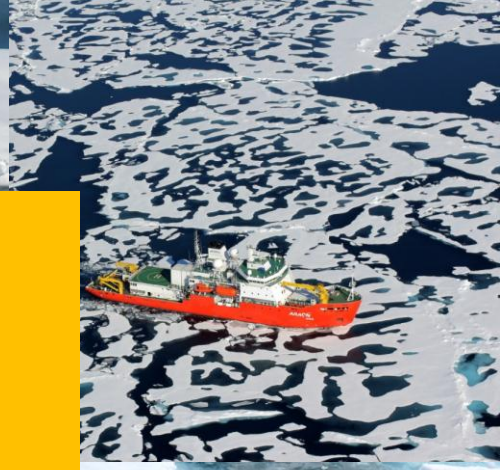
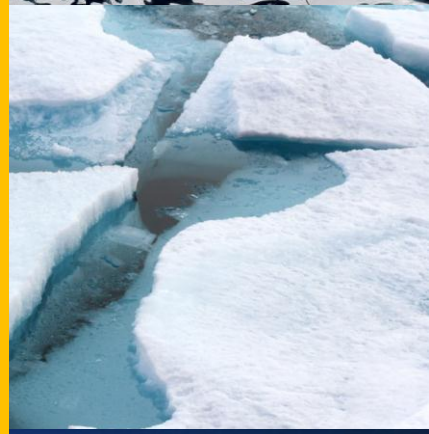
King Sejong Station (1988)

Jang Bogo Station (2014)

IceBreaker Research Vessel

ARAON



IBRV Araon

- Classification : KR PL-10

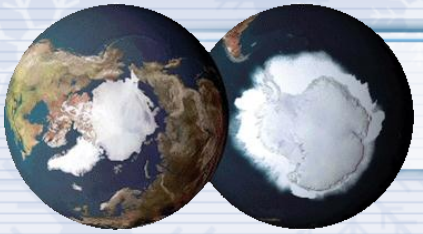
  1 m thick ice at 3 knot, DNV Polar 10 class
- Propulsion : Azimuth Thruster

  Diesel electric power : 10 MW (5 MW x 2)
- DP-2 System
- Length: 111 m
- Breadth: 19 m
- Cruise/Max Speed: 12/16 knots
- Gross tonnage: 7,487 ton
- Complement: 25 crews + 60 scientists
- Endurance : 20,000 nm (70 days)


Annual Operation of Araon

NOVEMBER - APRIL	**Antarctic Expedition**
MAY - JUNE	**Anchored in Ports of Korea** - Docking and Maintenance - Cargo un/loading - Sea trials
JULY - SEPTEMBER	**Arctic Expedition**
SEPTEMBER - OCTOBER	**Anchored in Ports of Korea**

KOPRI 극지연구소

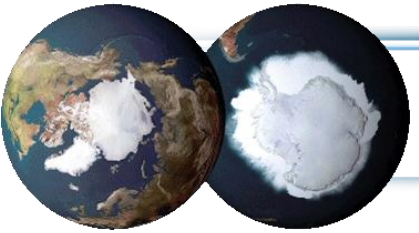


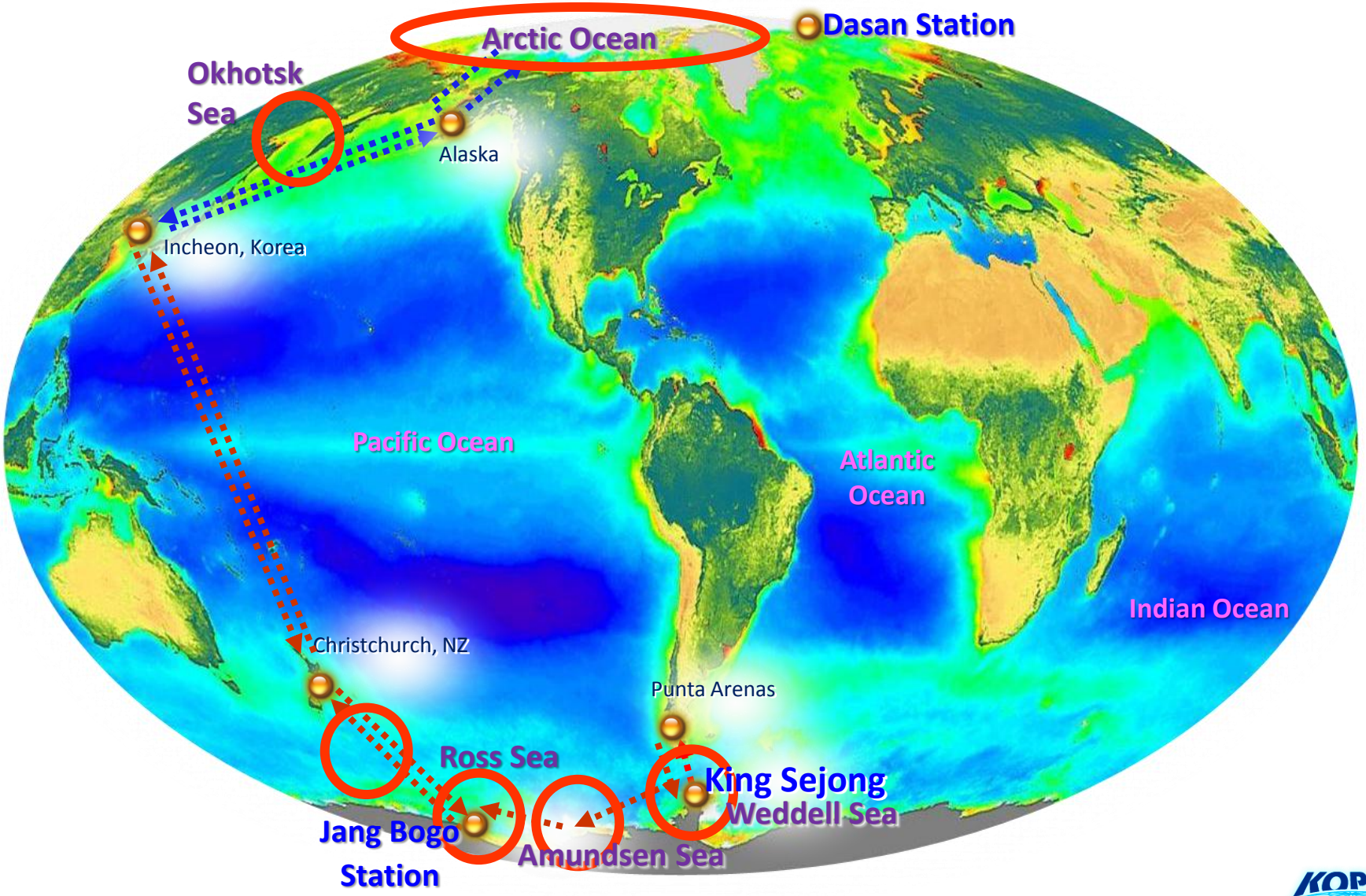
Araon operation in polar oceans

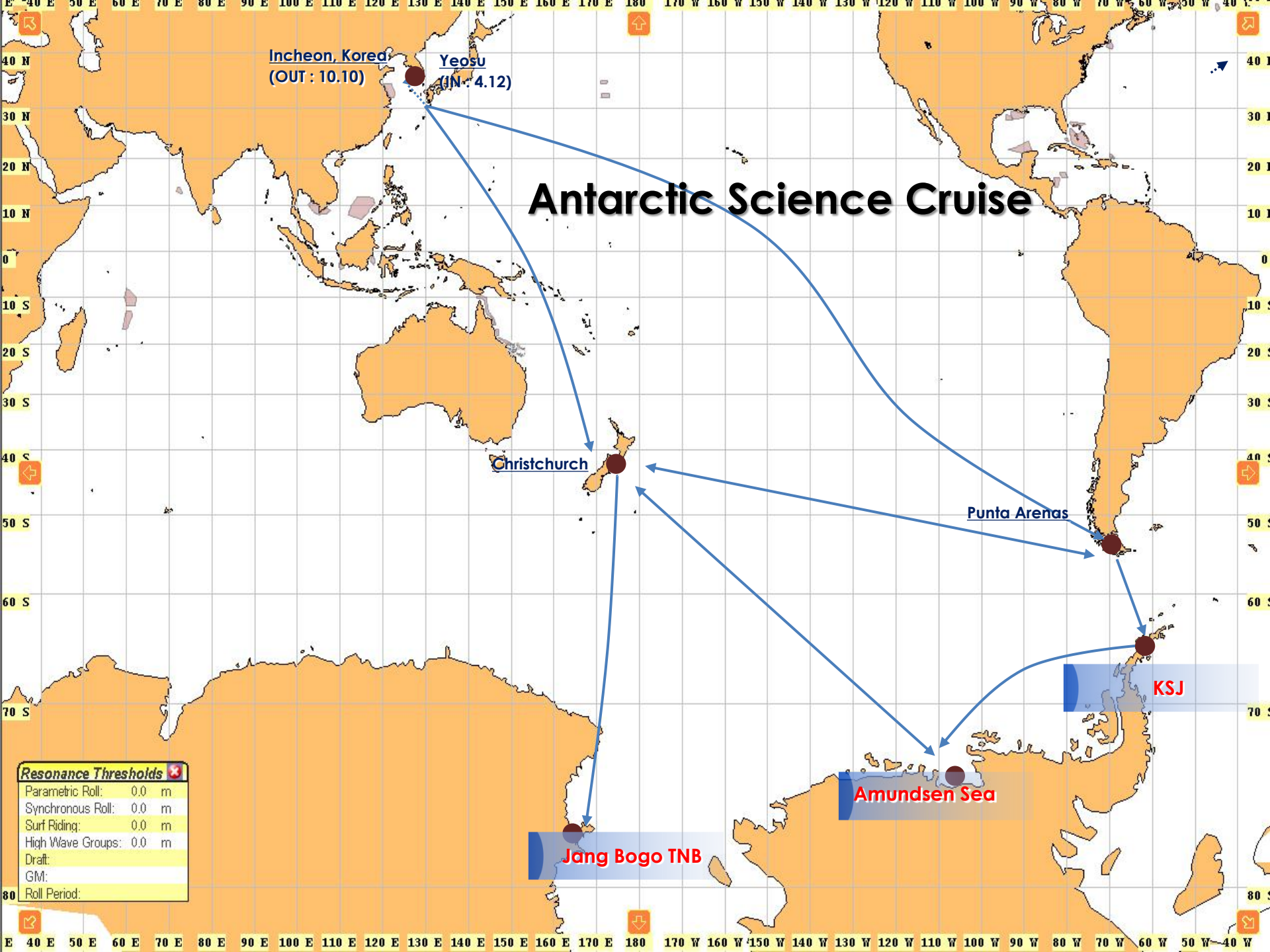
- 4 seasons so far; 2010, 2011, 2012, 2013
- Areas of operation; Chukchi, Beaufort, Ross, Amundsen, Weddell, underway
- Field campaign; atmosphere, ocean, sea ice, geophysics, paleoceanography
- Collaboration; Canada, China, Germany, Italy, Japan, Russia, Sweden, UK, USA.

KOPRI 극지연구소

Routine tracks of Araon






Antarctic Science Cruise
Incheon, Korea
(OUT : 10.10)
Yeosu
(IN : 4.12)
Christchurch
Punta Arenas
KSJ
Amundsen Sea
Jang Bogo TNB
Resonance Thresholds
Parametric Roll: 0.0 m
Synchronous Roll: 0.0 m
Surf Riding: 0.0 m
High Wave Groups: 0.0 m
Draft:
GM:
Roll Period:

Understanding Global Warming in the Western Arctic Ocean and its Estimation based on High-resolution Reconstruction of Paleoceanographic Changes from the Northwind-Mendeleev Ridges

Principal Investigator

KOPRI Project

Seung Il Nam

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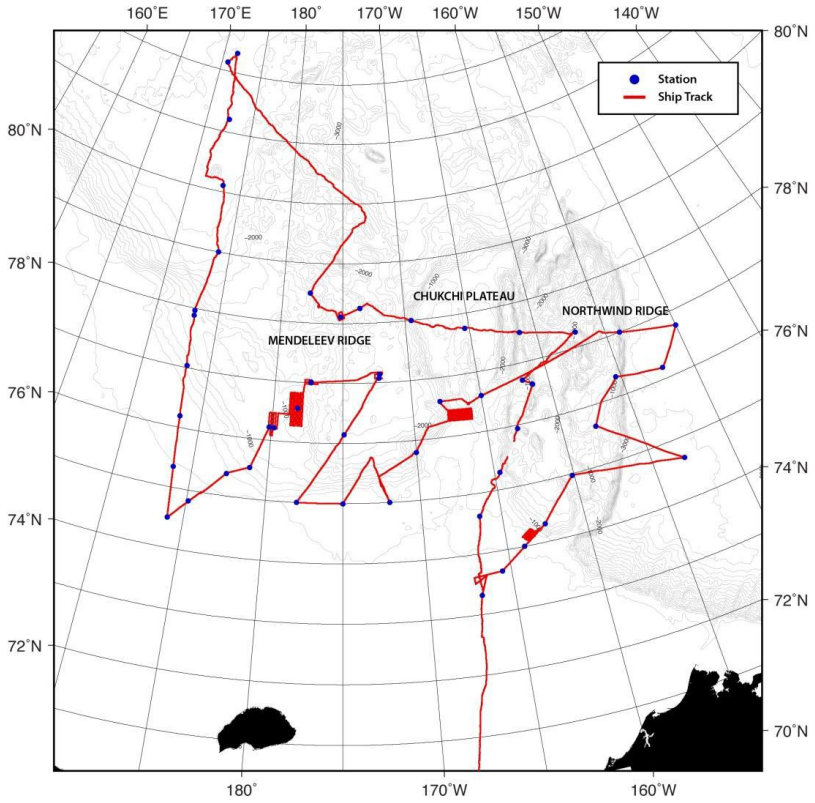
Study Area: Western Arctic Ocean

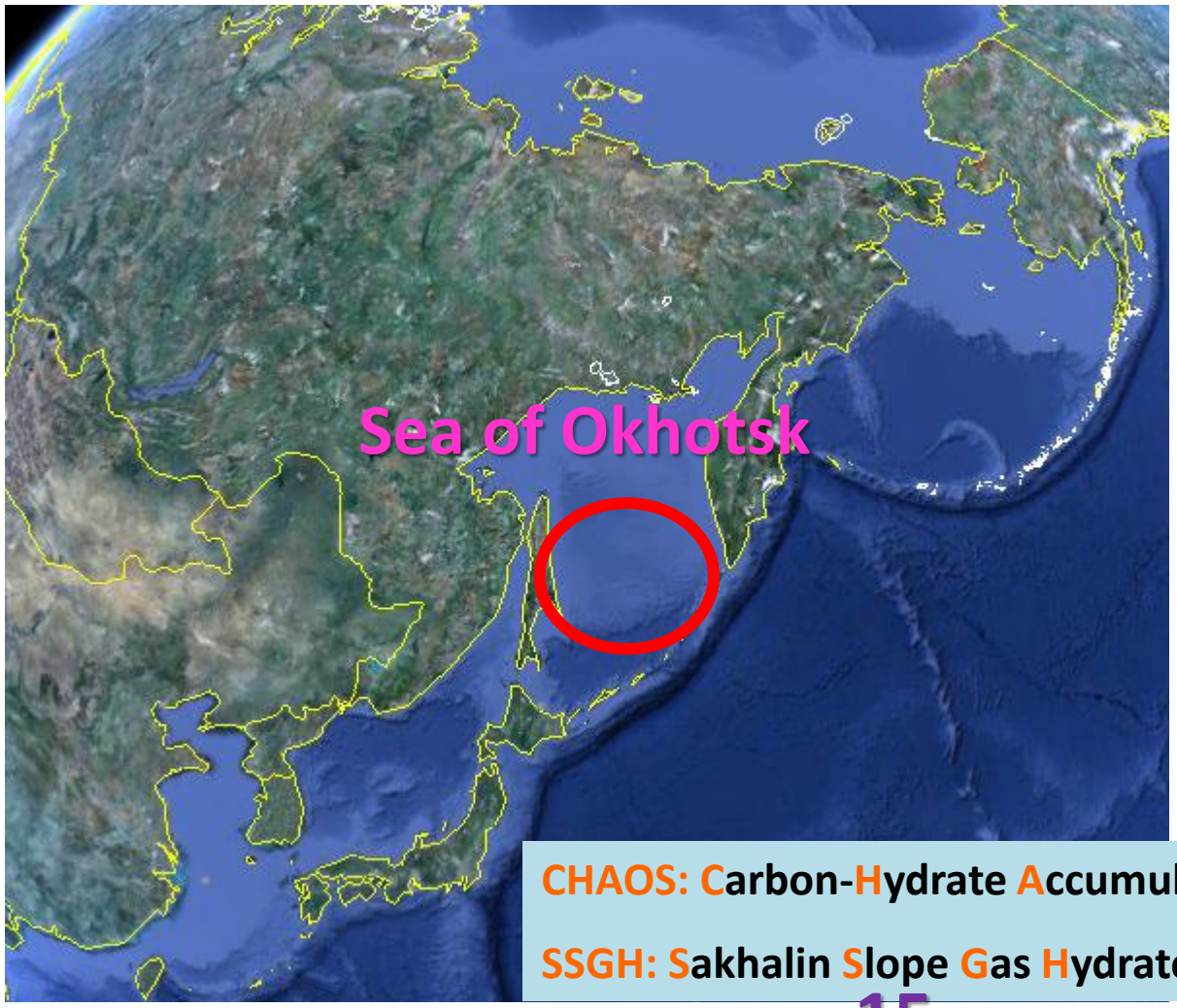


International Research Projects on gas hydrate and gas seeps on the Sakhalin Slope, Sea of Okhotsk

KOPRI Sponsored Project

Young Keun Jin

E-mail: ykjin@kopri.re.kr



CHAOS 2003

Sakhalin Slope Gas Hydrate Project 2007-2012

SSGH-10

Russia-Korea-Japan

CHAOS: Carbon-Hydrate Accumulations in the Okhotsk Sea

SSGH: Sakhalin Slope Gas Hydrate

KOPRI

Monitoring of Abrupt Environmental Changes in the Ice Shelf System and Reconstruction of Quaternary Deglaciation History in West Antarctica

Principal Investigator
Project
Hoil Yoon
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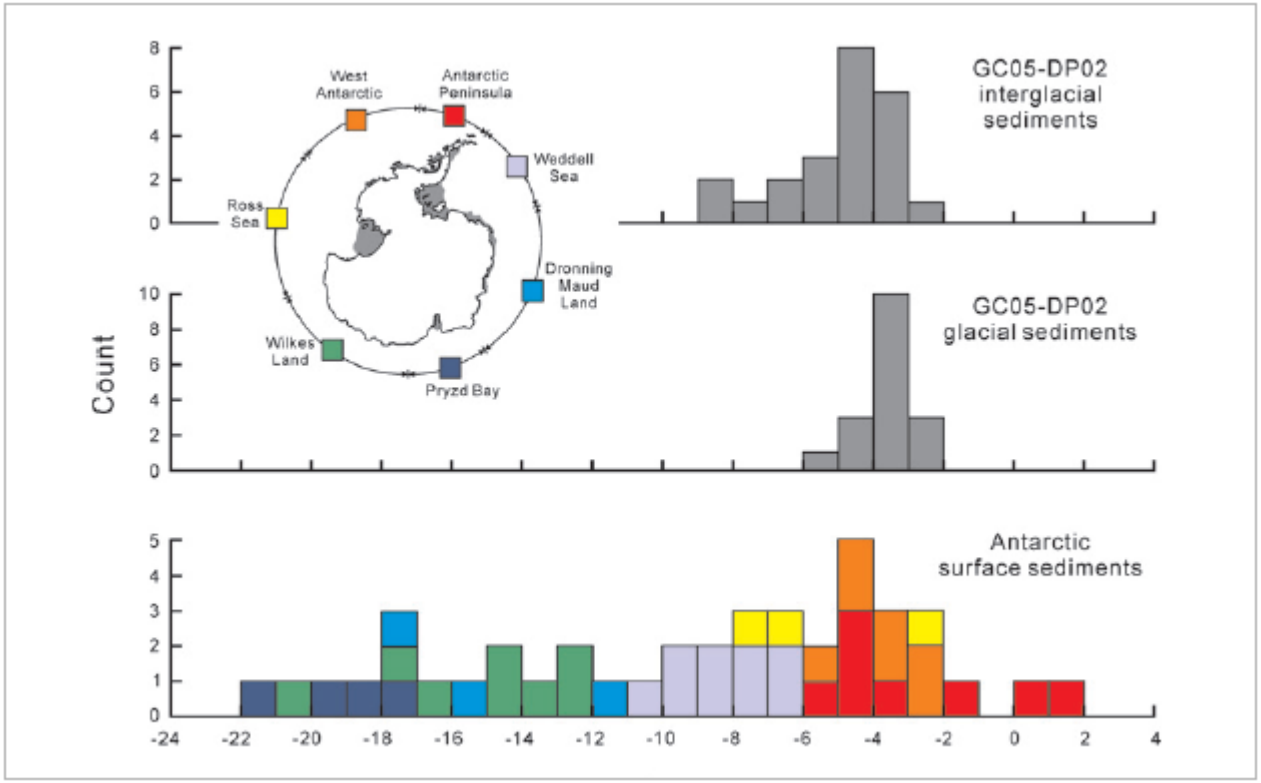
E-mail : hiyoon@kopri.re.k

Study Area: Weddell Sea, West Antarctica



Physical and Bio-geochemical Processes in the Polar Sea Regions: Their Roles & Responses to Global Climate Change

Principal Investigator

KOPRI Project

SangHoon Lee

E-mail : shlee@kopri.re.kr

Study Area: Amundsen Sea

Features

Cross-cutting of

Multidisciplinary studies

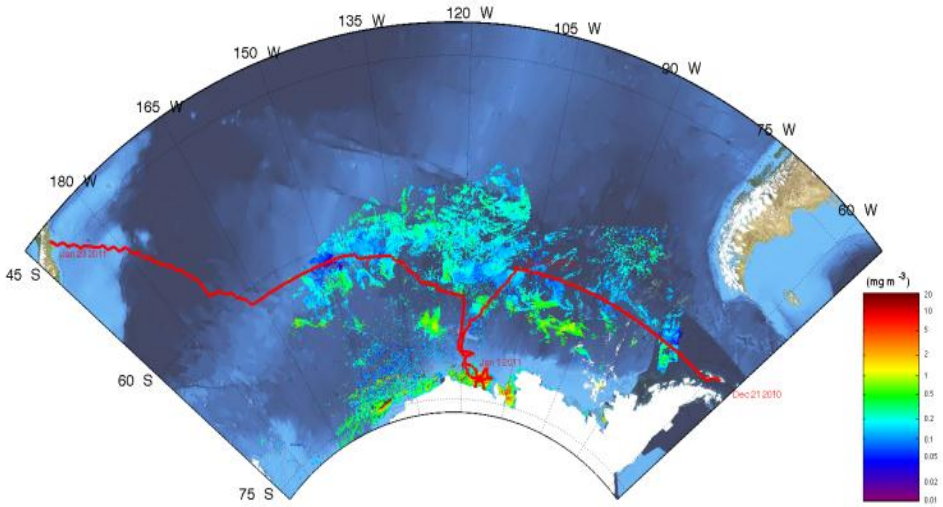
Multi- sites: from sea-ice margin, via sea ice, polynya, to ice-shelf edge

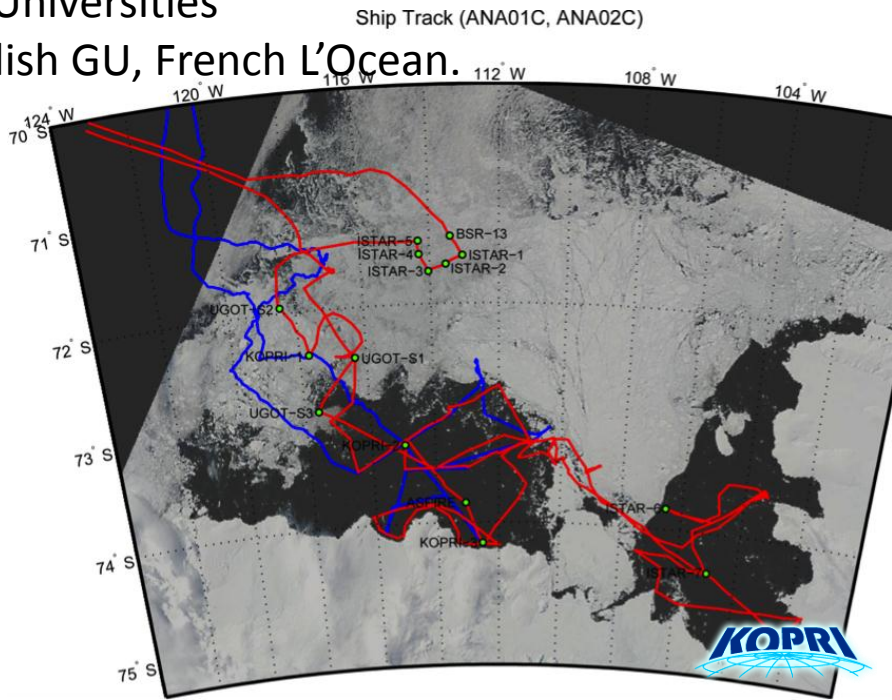
PLUS Underway Measurement from 38N to 75S

Multi-Level : Satellite – Air – Ocean – Ocean Floor (sed trap & core)

Multi-PI: 3 National Res Inst, 9 Domestic Universities

Multi-national: US Rutgers, UK BAS, Swedish GU, French L'Ocean.





2012 AMUNDSEN SEA CRUISE
31 JAN - 21 MAR

KOPRI


Lee, SangHoon


Rhee, Tae Siek


Hong, Sang bum


Yang, Eun Jin


Hahm, Doshik


Ha, Ho Kyung


Choi, Tae Jin


Moon, Heung Soo


Kim, Tae Wan


Hyun, Jung-Ho


Choi, Kyoung-Sik


Kim, Hyun-Soo


Park, Ji Soo


Han, Jeong Min


La, Hyoung Sul


Lee, Doo Byoul


Park, Ha Dong


Haam, Suk Hyun


Jeon, Hyun Duk


Kwun, Young Shin


Kim, Hyoung Jun


Park, Kyung A


Kim, Jin Woo


Kim, Seung Hee


Lee, Dong Jin


Jeon, Mi Sa

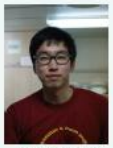

Lee, Seung Kyeo m


Lee, Hyoung-Bin


Jeong, Jin Hyun


Hong, Chang Su

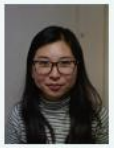

Choi, Gul-gi


Lee, JaeMan


Kim, Sung-Han


Choi, Ah-Youn


Kim, Jong-Geol


Kim, Mi Seon


Kim, Min Kyoung


Ha, Jung-Seok


Hwang, suna


Joo, Hui Tae


Abahamsen, Einar Povl


Baillnel, Benjamin


Christian, Stranne


Andrey Masanove


Leonid Tuyno


Julian Day


Dave Lewis


Maurice Sullivan

Impact of the Ocean-atmosphere Interactions in the Polar and Low-latitude Oceans to the Climate Change

Principal Investigator

KOPRI Project

Tae Siek Rhee

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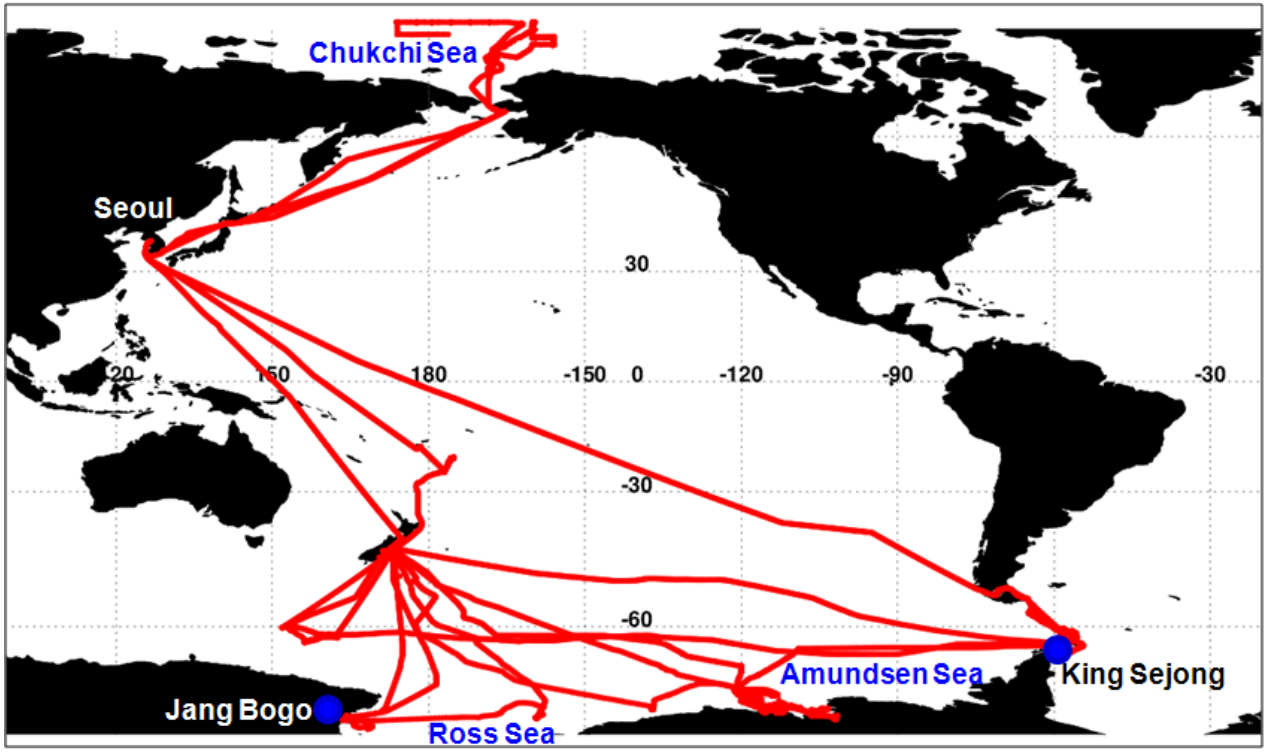
Study Area: Pole-to-Pole, Pacific Ocean

SHIpborne Pole-to-Pole Observations



Underway measurements of temperature, salinity, pigment, pH, greenhouse gases (CO_2, N_2O, CH_4), O_2; global changes, ocean warming, acidification

Araon's track covers the Pacific Sector of the Southern Ocean including the Amundsen Sea and the Ross Sea

KOPRI

Korea-Polar Ocean in Rapid Transition (K-PORT)

Bi-polar Ocean Study Area

Study Area: Chukchi and Ross Seas

Principal Investigator
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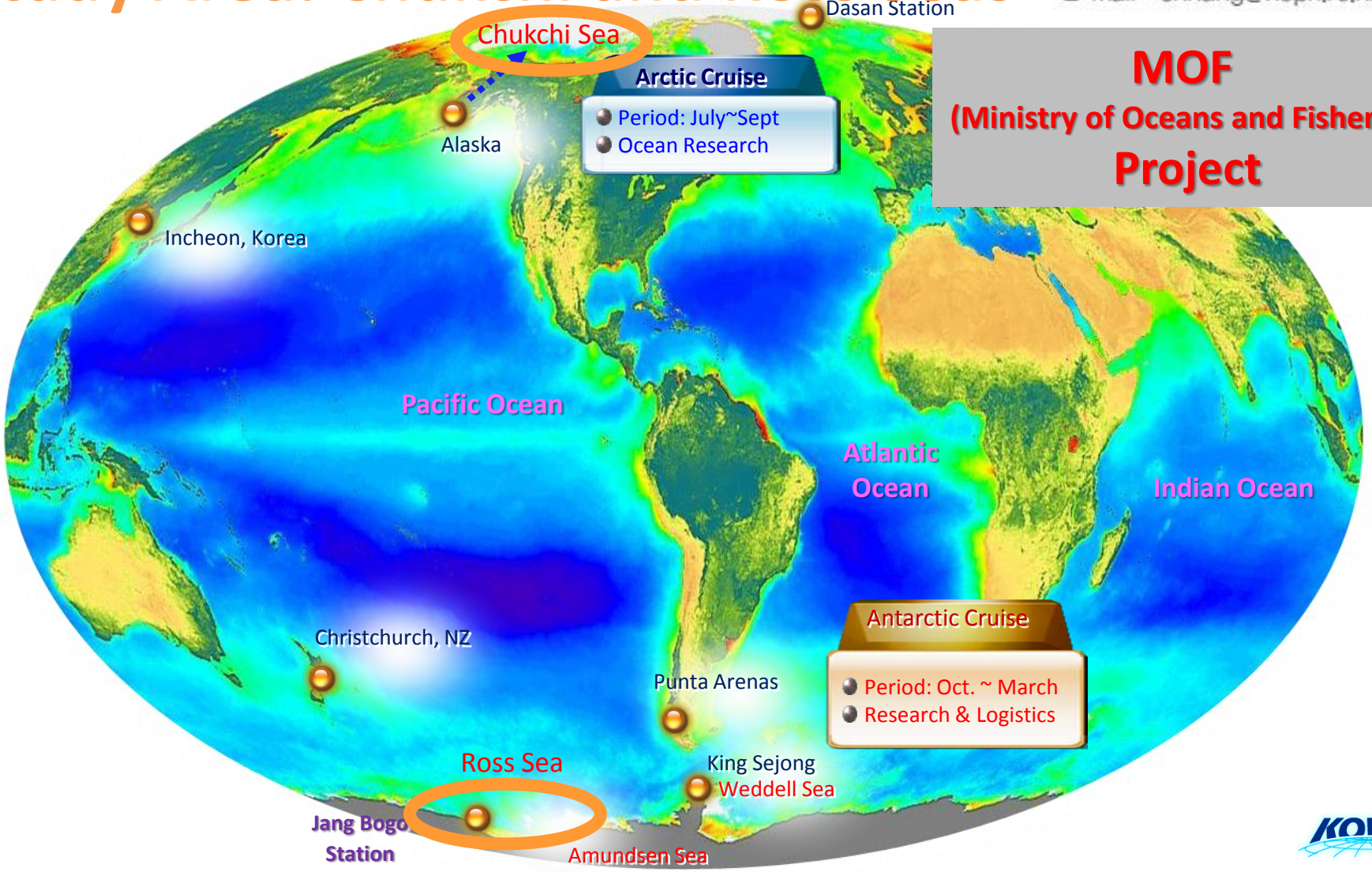
MOF
(Ministry of Oceans and Fisheries)
Project



Reconstruction and Observation of Components for the Annular Mode to Investigate the Cause of Climate Change at Polar Regions

Principal Investigator

Seong-Joong Kim

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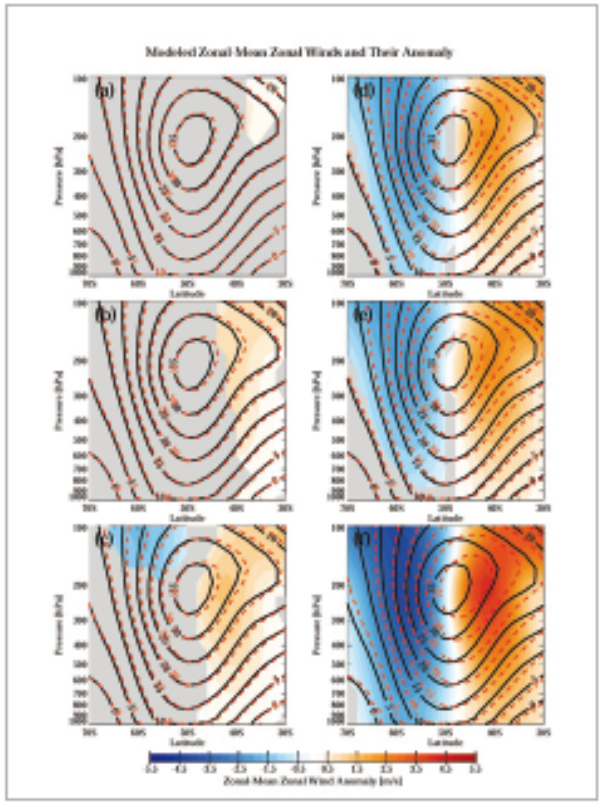
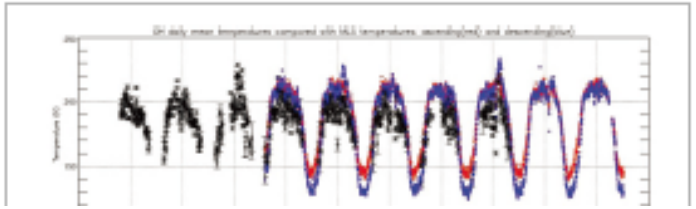


Annular mode is defined as the meridional pressure difference between mid latitudes and polar regions. When the annular mode is in positive phase, the westerly winds around the poles are enhanced and in the northern hemisphere, Siberia and middle North America becomes warmer than normal, while in the southern hemisphere, the Antarctic peninsula becomes warmer, but east Antarctica becomes colder than normal. On the other hand, when the northern annular mode is in negative phase, the meridional circulation is stronger and cold air could reach mid-latitudes. The annular mode variabilities are not only important in modulating the climate over polar areas, but also critical in understanding the climate in mid-latitudes. Therefore, understanding the mechanism of annular mode variability is necessary.

Our project aimed at investigating the role of annular mode components in polar climate change through observation and numerical model simulations of sea level pressure, surface air temperature, wind fields, etc. To achieve this purpose, detailed objectives in the year 2012 included the sensitivity of the annular mode in response to



Establishment of Circum Arctic Permafrost Environment Change Monitoring Network and Future Prediction Techniques (CAPEC Project)

Principal Investigator

Bang Yong Lee
Tel : 82-32-260-6230
E-mail : bylee@kopri.re.kr

Fig. 1. Plan for establishment of circum-Arctic permafrost environmental change monitoring nodes

The Arctic permafrost regions have experienced rapid thawing, but there have not enough monitoring programs and future projection trials for the on-going changes. It has become crucial and important to work with multi-national research bodies for the changes in the Arctic region. KOPRI has started to establish in-situ monitoring observation nodes over the permafrost areas around the Arctic by collaborating with other countries, under the umbrella of the project 'Establishment of Circum Arctic Permafrost Environment Change Monitoring Network and Future Prediction Techniques (CAPEC Project)' supported by the Ministry of Education, Science and Technology (MEST) since June 2011.

In 2011, KOPRI has established a research node in Alaska, USA to monitor the interactions between permafrost and the atmosphere. This project has further extended to Canadian permafrost regions in 2012. KOPRI has installed (1) 3-D eddy

Interaction between Cryosphere and Lithosphere near the Jang Bogo Station: Integrated Monitoring System for the David Glacier and Study on the Evolution of Glaciers

Principal Investigator

Won Sang Lee

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E-mail : wonsang@kopri.re.kr

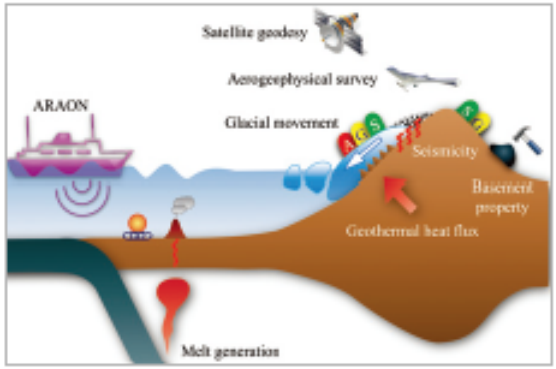

Fig. 1. Schematic figure to present the interaction between cryoshpere and lithosphere.

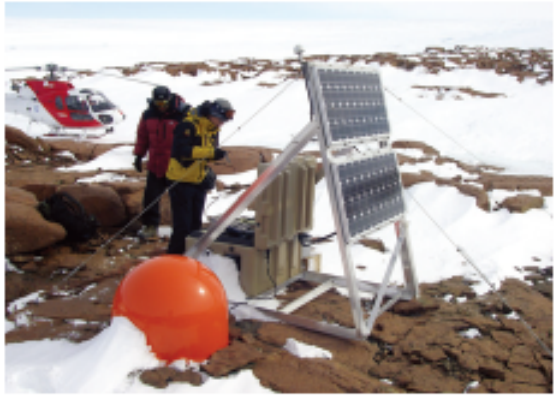

Fig. 2. Seismic station installed in the David Glacier region.

Variations of ice mass balance in polar regions triggered by climate change can interact with the lithosphere beneath ice. Geologic structures that have higher seismic activity and geothermal heat flux are likely to accelerate ice mass loss. The enhanced ice mass loss due to active geologic structures causes additional tectonic events such as glacial isostatic adjustments that may further affect ice mass changes (Fig. 1).

David Glacier, near Jang Bogo Station, is one of the largest and fastest glaciers in the Terra Nova Bay (TNB) region, and glaciers in this region have been known for some time to have negative mass balance, based on observational evidence. That makes David Glacier a good area for conducting research on ice mass balance and its interaction with the lithosphere.

We propose a combined terrestrial, marine, and satellite-borne geophysical expedition for the study area, in conjunction with a geological survey, to understand the current movement of David Glacier and its relation to tectonic structure in the TNB area. We have been operating 7 seismic stations (Fig. 2) and 4 GPS systems in David Glacier and 2 AMIGOS systems (Fig. 3) in the Drygalski Ice Tongue. Our plans for the upcoming field seasons involve conducting an air-borne ice radar survey to search subglacial lakes and map basal topography beneath glaciers, and installing more Ocean Bottom Seismographs to monitor submarine tectonic activities nearby. We anticipate that such a comprehensive geophysical observation system for the David Glacier will provide us useful clues to understanding the interaction between cryosphere and lithosphere, in turn we could evaluate their impact on cryospheric environment nearby through a novel ice dynamic model (Fig. 4).

Korea Curation of Antarctic Meteorites and Evolution of Planetary Materials

Principal Investigator

Jong Ik Lee

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KOPRI has set up a curation system which controls recovery, classification, storage, registration and distribution of Antarctic meteorites since 2011. The Korea Curation of Antarctic Meteorites (*KOREAMET*) is the 4th curation system in the world, following the USA, Japan and Italy. KOREAMET is operating a homepage (koreamet.kopri.re.kr) for release of information to the public and researchers on the Antarctic meteorites collected by KOPRI. In February 2012, 36 meteorites which were recovered during the 2010/11 joint expedition between KOPRI and PNRA were classified and registered at the Meteoritical Society.

To develop a core technology for the study of evolution of early planetary materials, the resolution and accuracy of a laser fluorination oxygen isotope analysis system which has been operating from 2007 has been greatly improved. Specifically, a new technology for complete extraction of oxygen gases up to 100% from hydrous carbonaceous chondrites was developed. An analytical technology of Sr-Nd-Pb radiogenic isotopes using 10 ng with thermal ionization mass spectrometer (TIMS) was developed for the study of the evolution of terrestrial planets. A new field emission electron probe micro analyzer (FE-EPMA) for the quantitative analysis of

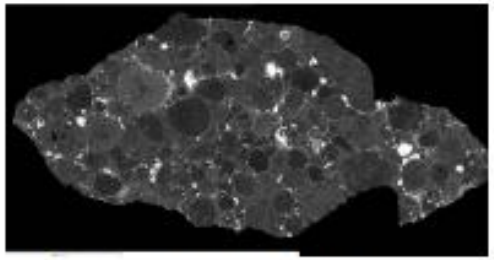

Fig. 1. Back scattered image of FRO 10096 ordinary chondrite

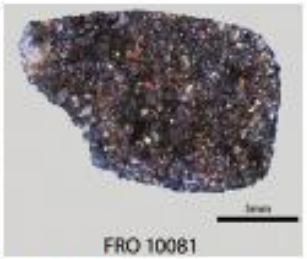

Fig. 2. A photomicrograph of FRO 10081 ordinary chondrite, crossed nicol

Fig. 3. A remote camp at Prince Albert Mountain, Victoria Land (S75°50', E158°29')

Functional Genomics on Polar Organisms

Principal Investigator

Hyun Park

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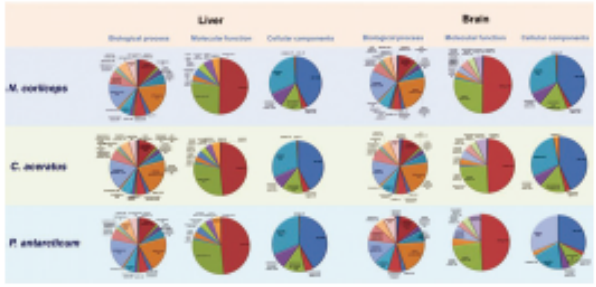

Fig. 1. Gene annotation of three Antarctic fishes

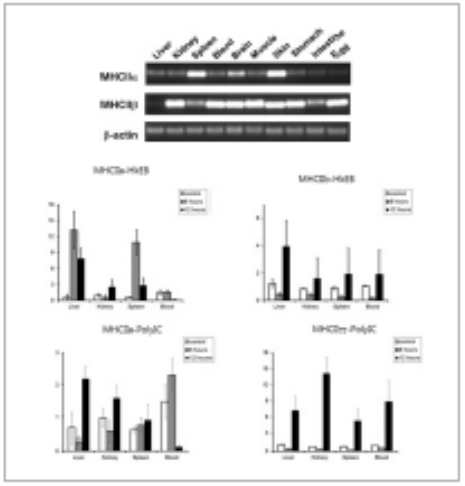

Fig. 2. Expression patterns of Antarctic *Notothenia coriiceps* MHCII genes

Genomics is a high-profile science impacting on all areas of biology. Functional genomics studies focus particularly on dynamic aspects such as gene transcription, translation, and protein-protein interactions in attempts to answer questions about the functions of DNA at the genetic level, RNA transcripts, and protein products.

Although the Antarctic is often viewed as one of Earth's last great frontiers, the extreme climates, combined with months of complete or near darkness provide inhospitable conditions for life. The evolutionary history and geographical isolation of the Antarctic has produced a unique environment, rich in species adapted to extreme conditions. So it provides unparalleled tools for studying natural selection in action and investigating the link between organisms and the environment. The Antarctic functional genomics project is their genome-wide approach to these questions for various Antarctic biotas, such as fishes, amphipodas, plants, lichens and microorganisms involving high-throughput methods (Fig. 1-3).

For these purposes, *Deschampsia antarctica*, the only monocot plant in the maritime Antarctic, has been chosen for the best target plant species. Because of its successful adaptation to climate change and rapid spread, *D. antarctica* has been studied in a wide range of biological fields and has been suggested as an ecological marker of global warming and a valuable resource for the discovery of genes associated with stress tolerance. To reveal genetic interactions between plants and the Antarctic environment, rice transgenic lines ectopically expressing stress response genes for cold and drought stresses from *D. antarctica* were studied for their functional

Utilization of Novel Metabolites from Polar Organisms

Principal Investigator

Joung Han Yim

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E-mail : jhyim@kopri.re.kr

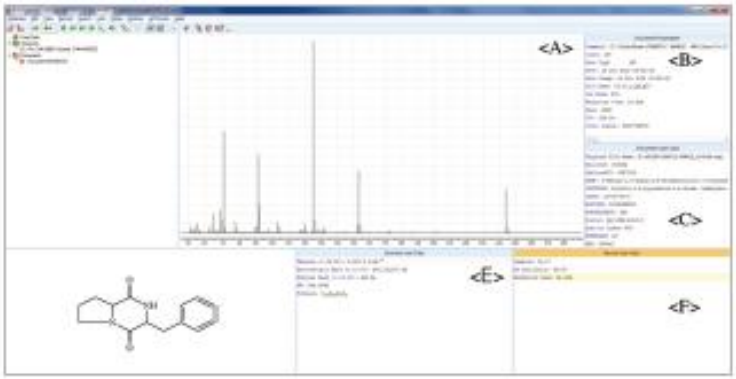

Fig. 1. The feature of library on Antarctic marine actinomycetes 10-17. (A) mass spectrum, (B) analytical conditions, (C) information on the derivatives in library, (D) exact structure, (E) basic information on structure, (F) information on the peak.

Fig. 2. Pure cultures of polar mosses. (A) M9, (B) Funaria sp. (C) M11.

The purpose of this project is to activate polar biological research by obtaining metabolites, defining living mechanisms, and to commercialize novel biomaterials from polar cold-adapted organisms. The research project started in 2011.

In order to procure the biological metabolites from polar organisms, total 114 species of plants, 10 species of mosses and 45 species of lichens from the Yakutsk, Baikal and Kachatka, Russia, were collected in 2012, the second year of the project. We also acquired 35 species of plants and 116 samples from the Korean Arctic Dasan station. The methanol extracts from 70 samples collected in Yakutsk were analyzed using LC/MS or GC/MS and 305 metabolites library was constructed (Fig. 1). To fulfil continuous sampling for metabolites isolation from polar organisms, we are maintaining the pure cultures of Antarctic and Arctic mosses in laboratory (Fig. 2).

Ramalin, a new antioxidant from the Antarctic lichen *Ramalina terebrata*, showed excellent validity effect on the hepatocirrhosis therapy (Fig. 3). Protease, a proteolytic enzyme, from Antarctic microorganism has a powerful psychrophilic activity. We also confirmed that the

Studies on Biodiversity and Changing Ecosystems in King George Island, Antarctica (BioCE)

Principal Investigator

Han-Gu Choi

Tel : 82-32-260-6162

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We investigated the biodiversity and changing ecosystems in King George Island, Antarctica and evaluated the Antarctic terrestrial and coastal marine ecosystems responses caused by climate change based on multidisciplinary studies (Fig. 1).

This international collaboration with seven countries, investigated the red algae Bangiales based on a worldwide sampling from tropical to Antarctic seas using molecular data. The phylogenetic relationship of order Bangiales was revised and genus *Porphyra* was reconstructed into four independent genera. In particular, Antarctic redalga, *Porphyra endiviifolium* A. Gepp et E. Gepp was renamed as *Pyropia endiviifolia* (A. Gepp et E. Gepp) H.-G. Choi et M.S. Hwang comb. nov. We collected and identified about 20 species of 14 genera of mosses near the King Sejong Station (Fig. 2). We also, investigated the Antarctic invertebrate fauna, identifying 20 pelagic copepods, 15 amphipods, and several marine invertebrates such as barnacles and ciliates. We are constructing the KOPRI Virtual Herbarium web-site (http://kvh.kopri.re.kr/main/main.php) which serves as the source of information of species collected in the Arctic and Antarctic regions, such as sampling sites, physiological traits, genetic information and digital specimen images.

To understand the effects of topography on local climate, temperature loggers were installed all over the Barton Peninsula. Temperature records during the last year suggested that topographic effects on climate were great enough to affect floral distribution and microbial diversity.

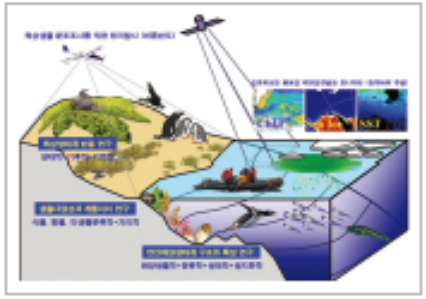


Fig. 1. Multidisciplinary studies on biodiversity and changing ecosystems in King George Island, Antarctica (BioCE)

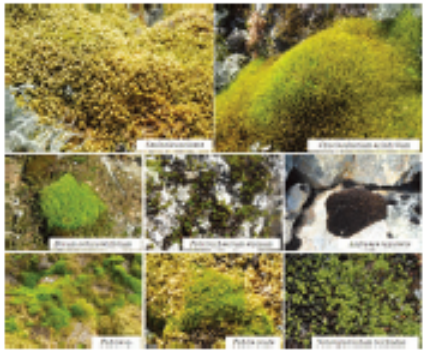
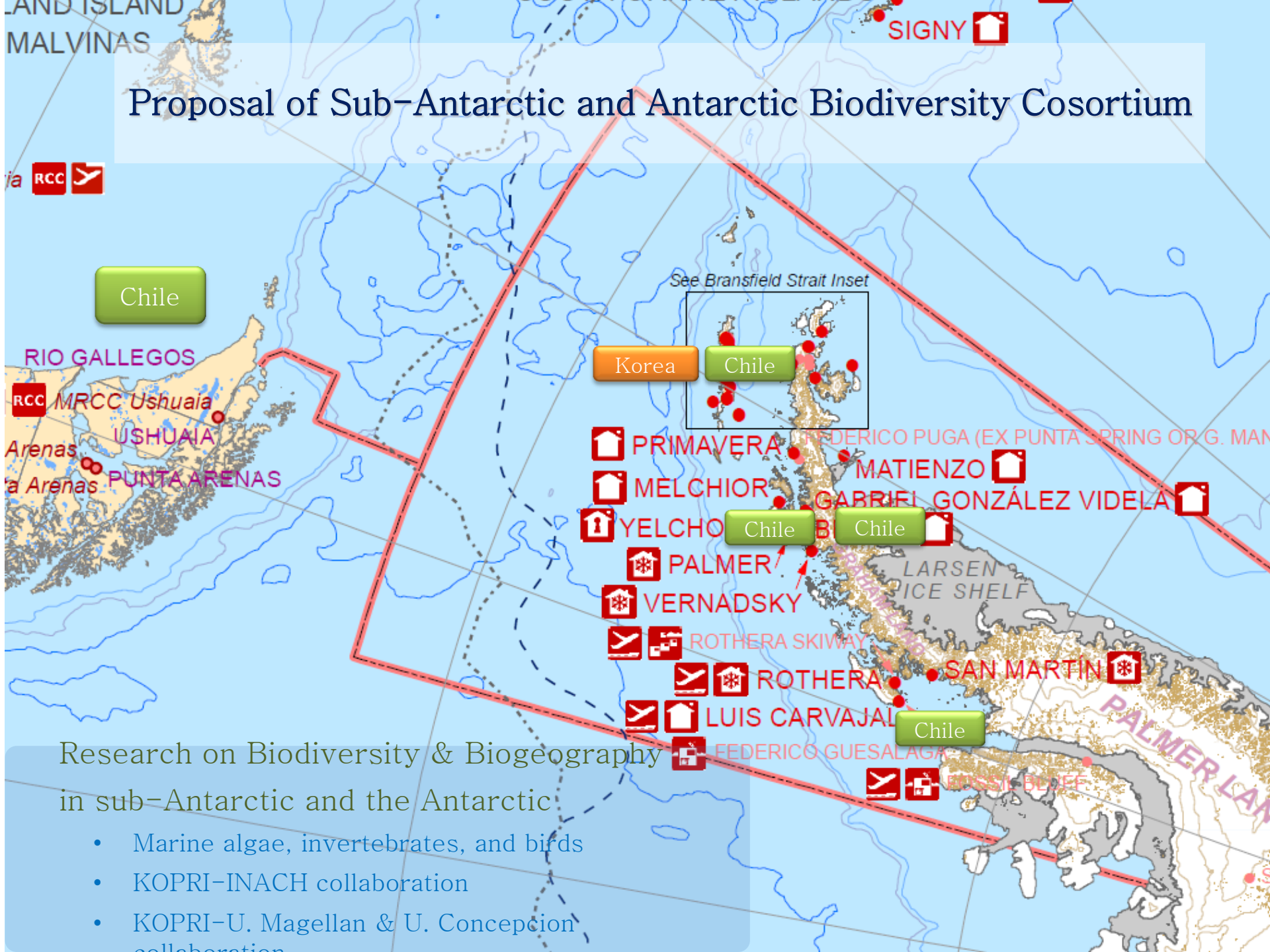


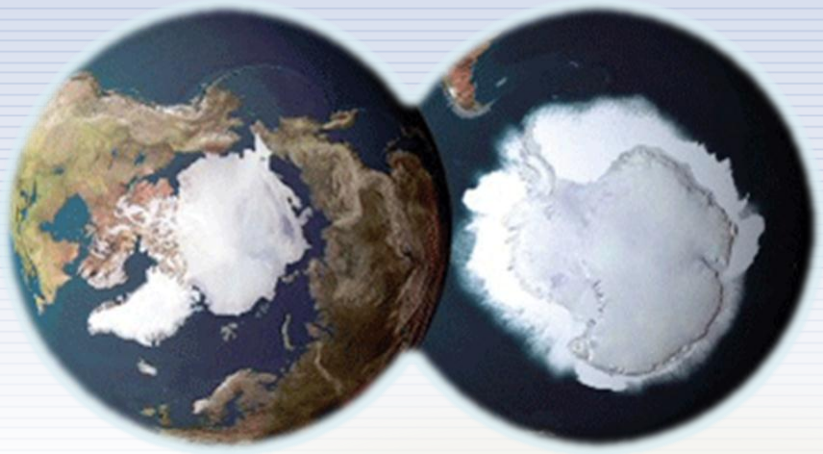
Fig. 2. Mosses found around King Sejong Station, Antarctica

Proposal of Sub-Antarctic and Antarctic Biodiversity Cosortium



Research on Biodiversity & Biogeography in sub-Antarctic and the Antarctic

- Marine algae, invertebrates, and birds
- KOPRI-INACH collaboration
- KOPRI-U. Magellan & U. Concepcion collaboration



Muchas Gracias

KOPRI 극지연구소