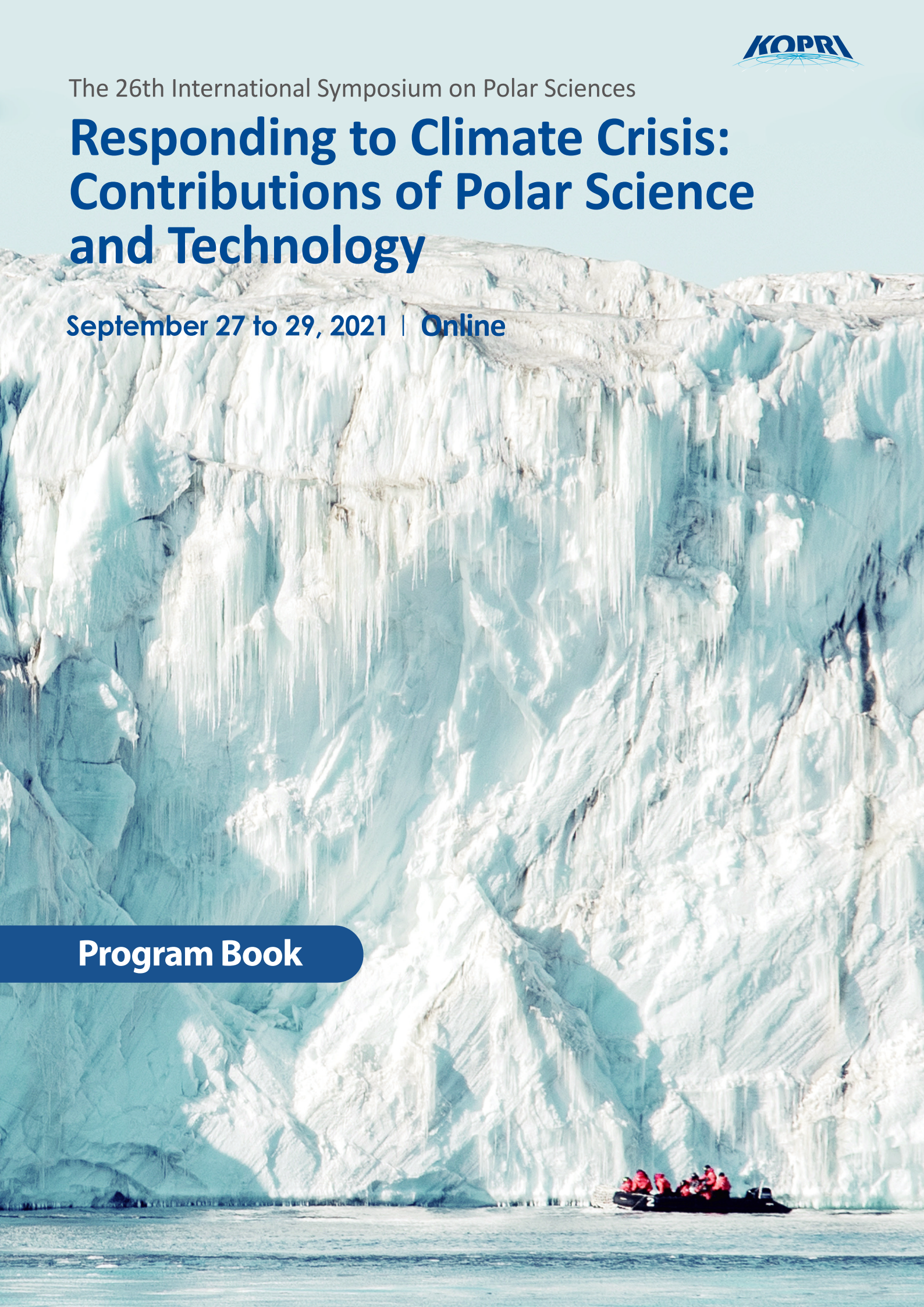
The 26th International Symposium on Polar Sciences

Responding to Climate Crisis: Contributions of Polar Science and Technology

September 27 to 29, 2021 | Online



Program Book

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Welcome Message

Sung-Ho Kang
President, Korea Polar Research Institute

Dear colleagues and participants,

It gives me great pleasure to welcome you all to the 26th International Symposium on Polar Sciences (ISPS2021).

Like so many events worldwide, the pandemic has put severe restrictions on how we meet. We were hoping to welcome you in Incheon, but after careful consideration of the evolving circumstances, we made a difficult decision to hold the symposium online.

These challenging circumstances remind us of the importance of international collaboration in addressing the issues of global concern. It also reminds us that science is the key that enables us to better understand and respond to nature's challenges.

This year's symposium focuses on the greatest crisis of our times: the climate change. We have witnessed many communities suffering from heatwave, drought and wildfire, while others suffered heavy rainfall, typhoon and flood. We are facing extreme events at an unprecedented rate, and they require our immediate attention.

The polar regions are essential in this unfolding climate crisis, as these regions are especially sensitive to climate change. Warming twice as fast as the global average, the polar regions are becoming both the barometer and accelerator of global climate change. Our role is to continue the observation, and provide scientific understanding and prediction upon which we can implement mitigation efforts. In this respect, this online symposium has much to offer by shedding light on the new understanding in areas of polar science and technology.

During this year's symposium, we will have the opportunity to discuss the findings in polar sciences that are closely linked to climate changes, and the cutting-edge technologies that enable more efficient and sustainable monitoring under harsh environments.

I am confident that during the forthcoming sessions, you will find inspirational presentations with keen insights, and have a chance to participate in interesting and stimulating discussions.

I hope you stay safe and well, and hope to see you online. Thank you.

The 26th ISPS Steering Committee

Sang-Jong Park	Korea Polar Research Institute	
Changhyun Chung	Korea Polar Research Institute	
Joo-Hong Kim	Korea Polar Research Institute	
Ok-Sun Kim	Korea Polar Research Institute	
Sukyoung Yun	Korea Polar Research Institute	
Yeongcheol Han	Korea Polar Research Institute	
Jihoon Jeong	Korea Polar Research Institute	Secretariat
Chaerin Jung	Korea Polar Research Institute	Secretariat

Program at a Glance

Day 1 September 27 (Monday)

Time	Program	Place
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Day 2 September 28 (Tuesday)

Time	Program	Place
09:00-09:30	Opening and Welcoming Remarks	Online
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10:00-11:40	Session 1. Polar climate science in the context of global climate crisis	Online
11:40-13:00	BREAK	-
13:00-13:30	Plenary Lecture 2 | **Ted Scambos** (University of Colorado Boulder)	Online
13:30-15:00	Session 2. Cryosphere evolution and sea-level change	Online
15:00-15:30	BREAK	-
15:30-16:00	Plenary Lecture 3 | **Michael Karcher** (Alfred Wegener Institute)	Online
16:00-17:30	Session 3. Sea ice and polar oceans in rapid transition	Online

Day 3 September 29 (Wednesday)

Time	Program	Place
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09:55-10:20	Plenary Lecture 5 | **Drew Taylor** (Remote Sensing Center, The University of Alabama)	Online
10:20-11:20	Session 4. Technological advances enabling new polar science	Online
11:20-13:00	BREAK	-
13:00-13:30	Plenary Lecture 6 | **John Priscu** (Montana State University)	Online
13:30-15:10	Session 5. Integrated study of subglacial Antarctic lake ecosystem	Online
15:10-15:30	BREAK	-
15:30-18:00	Session 6. A paleoclimate perspective on climatic and environmental extremes : Korea-Italy Jointed Workshop on STREAM (Final year)	Online
18:00-18:30	Announcement of Early Career Poster Award winners and Closing Remarks	Online

Detailed Program

Day 1 September 27 (Monday)

Public Lecture — Online

15:00-16:00 **Responding to Climate Crisis: Contributions of Polar Science and Technology**
Seong-Joong Kim (Korea Polar Research Institute)

Day 2 September 28 (Tuesday)

Opening & Welcoming Remarks — Online

09:00-09:30 **Welcoming remarks**
Sung-Ho Kang (President of Korea Polar Research Institute)

Plenary Lecture 1 — Online

09:30-10:00 **High-resolution climate modelling from a polar perspective**
Thomas Jung (Alfred Wegener Institute)

Session 1 _ Polar climate science in the context of global climate crisis — Online

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Heeje Cho (Korea Polar Research Institute)

10:20-10:40 S1 02 **Recent weakening of the southern stratospheric polar vortex and its impact on the surface climate over Antarctica**
Hataek Kwon (Seoul National University)

10:40-11:00 S1 03 **Lightning occurrence observation using electromagnetic field measurement surrounding Antarctica Peninsula**
Sulaiman Ali Mohammad (National University of Malaysia)

11:00-11:20 S1 04 **Formation of marine secondary aerosols in the Southern Ocean, Antarctica**
Shanshan Wang (Third Institute of Oceanography)

11:20-11:40 S1 05 **Spatio-temporal variations of Black Carbon over Arctic in a regional climate model**
Rohit Srivastava (National Centre for Polar and Ocean Research)

Plenary Lecture 2 — Online

13:00-13:30 **The Thwaites-Amundsen ice-ocean system: current results from the International Thwaites Glacier Collaboration**
Ted Scambos (University of Colorado Boulder)

Session 2 _ Cryosphere evolution and sea-level change

Online

13:30-13:45 **S2 01**
Investigating the role of Marine Ice Cliff Instability in the Amundsen Sea Sector over the next century
Mathieu Morlighem (Dartmouth College)

13:45-14:00 **S2 02**
Repeat radar survey and basal evolution of Thwaites Glacier, West Antarctica.
Lucas Beem (Montana State University)

14:00-14:15 **S2 03**
Pathways and heat transports of Circumpolar Deep Water into the Thwaites and Pine Island Glaciers, West Antarctica
HyungBo Kim (Seoul National University)

14:15-14:30 **S2 04**
Holocene relative changes in the White Sea level according to paleolimnological data
Dmitriy Subetto (Herzen State Pedagogical University of Russia)

14:30-14:45 **S2 05**
Polynya Preconditioning: Ocean Processes South of the Drygalski Ice Tongue, Western Ross Sea
Craig Stevens (National Institute of Water and Atmospheric Research, University of Auckland)

14:45-15:00 **S2 06**
Antarctic ice mass change (2003-2016) jointly estimated by satellite gravimetry and altimetry
Byeong-Hoon Kim (Korea Polar Research Institute)

Plenary Lecture 3

Online

15:30-16:00
Arctic PASSION - a new 4-year program to advance a pan Arctic Observing System of Systems in support of societal needs
Michael Karcher (Alfred Wegener Institute)

Session 3 _ Sea ice and polar oceans in rapid transition

Online

16:00-16:15 **S3 01**
Intensified Arctic Cyclone Activities and Observed Driving Mechanisms for Accelerating Summer Sea Ice Decrease
Xiangdong Zhang (University of Alaska Fairbanks)

16:30-16:45 **S3 03**
A remote sensing approach to estimate under-ice light and algal bloom onset on a pan-Arctic scale
Gaëlle Veyssiere (British Antarctic Survey)

16:45-17:00 **S3 04**
Development of KOPRI's operational high-resolution sea ice drift product
Jeong-Won Park (Korea Polar Research Institute)

17:00-17:15 **S3 05**
Intensive oceanographic and geophysical observation campaign off Sabrina Coast, East Antarctica, in 2019/2020
Shigeru Aoki (Hokkaido University)

17:15-17:30 **S3 06**
Opposing decadal trend of wintertime mixed layer depth in the Pacific and Indian sectors of the Southern Ocean from 2005 to 2019
Hajoon Song (Yonsei University)

Day 3 September 29 (Wednesday)

Plenary Lecture 4 — Online

09:30-09:55 **Engineering and Science Support for U.S. Antarctic Program**
Rosa T. Affleck (Cold Regions Research and Engineering Laboratory)

Plenary Lecture 5 — Online

09:55-10:20 **A new airborne ultra-wideband radar system for polar surveys**
Drew Taylor (Remote Sensing Center, The University of Alabama)

Session 4 _ Technological advances enabling new polar science — Online

10:20-10:35 **S4 01** **Aero-Structural Design and Analysis of Pylons for a 16-Element Airborne Radar Antenna Array**
Mishal Thapa (Remote Sensing Center, The University of Alabama)

10:35-10:50 **S4 02** **The Architecture of Fault-Tolerant Networks for Remote Data Acquisition in Polar Regions**
Jinyoung Lee (Kookmin University)

10:50-11:05 **S4 03** **Estimation of high-resolution sea ice motion in the Arctic Ocean using Sentinel-1 image**
Gwang Seob Park (Korea Institute of Ocean Science & Technology)

11:05-11:20 **S4 04** **Passive microwave satellite L-band sensor-based polar sea ice surface roughness retrieval and its variation analysis**
Suna Jo (Department of Environment, Energy, and Geoinfomatics, Sejong University)

Plenary Lecture 6 — Online

13:00-13:30 **Antarctic Subglacial Lakes: Oases for Life in a Polar Desert**
John Priscu (Montana State University)

Session 5 _ Integrated study of subglacial Antarctic lake ecosystems — Online

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Mark Skidmore (Montana State University)

13:50-14:10 **S5 02** **Holocene marine incursion supports a subglacial microbial community in the active hydrologic system beneath the West Antarctic Ice Sheet**
Brad Rosenheim (University of South Florida)

14:10-14:30 **S5 03** **Metabolic potential in Subglacial Lake Mercer inferred from single-cell genomic data**
Kyungmo Kim (Korea Polar Research Institute)

14:30-14:50 **S5 04** **What can we learn from clay mineralogy of SLM sediment?**
Jinwook Kim (Yonsei University)

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S5 05

Subglacial lake floods correlated with the ice tongue disintegration in the Thwaites Glacier, Antarctica

Choon-Ki Lee (Korea Polar Research Institute)

Session 6 _ A paleoclimate perspective on climatic and environmental extremes : Korea-Italy Jointed Workshop on STREAM (Final year)

Online

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Microstructure of lamination in core RS15-LC42 in the Central Basin of the northwestern Ross Sea: preliminary results

Boo-Keun Khim (Pusan National University)

15:45-16:00
S6 02

Reconstruction of cryospheric and paleoceanographic changes of the past 1 Myrs from the record at the continental margin, NW Ross Sea

Min Kyung Lee (Korea Polar Research Institute)

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S6 03

Pre-LGM sedimentological feature and paleo oceanographic changes in the Central Basin (Western Ross Sea)

Fiorenza Torricella (Università di Pisa)

16:15-16:30
S6 04

Past and recent sedimentary dynamics recorded in sedimentary cores collected east of the Iselin Bank (Ross Sea, Antarctica)

Ester Colizza (University of Trieste)

16:30-16:45
S6 05

Multidisciplinary analysis of three box cores collected east to the Hillary Canyon (Eastern Ross Sea, Antarctica)

Andrea Geniram (University of Trieste)

16:45-17:00
S6 06

Depositional processes in the Drygalski Basin of the Ross Sea since the Last Glacial Maximum

Sangbeom, Ha (Pusan National University)

17:00-17:15
S6 07

Late Pleistocene glacial-interglacial paleoceanographic changes in the Ross Sea

Sunghan Kim (Korea Polar Research Institute)

17:15-17:30
S6 08

Bottom-current-controlled sedimentary and geomorphic processes in the northwestern Ross Sea margin, Antarctica

Sookwan Kim (Korea Polar Research Institute)

17:30-17:45
S6 09

Tephrochronology in the Western Ross Sea and its role in paleoenvironmental analyses

Paola Del Carlo (Istituto Nazionale di Geofisica e Vulcanologia)

17:45-18:00
S6 10

Changes in the minero-petrographic composition of late Quaternary sediments in the slope-basin area of Western Ross Sea (Antarctica)

Luca Zurli (University of Siena)

Announcement of Early Career Poster Award winners and Closing Remarks

Online

18:00-18:30

Closing remarks

Sung-Ho Kang (President of Korea Polar Research Institute)

List of Posters

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Ahra Mo (Korea University)

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Andryi Fedchuk (National Antarctic Scientific Center of Ukraine)

P1 03 **Temperature waves: temporal variability of threshold temperatures in the Arctic**
Elena Grigorieva (Institute for Complex Analysis of Regional Problems, Far Eastern Branch of the Russian Academy of Sciences)

P1 04 **First-year sea ice reads to increase in dimethyl sulfide-derived particle formation in the Antarctic Peninsula**
Eunho Jang (University of Science and Technology)

P1 05 **Assessment of Tethered Balloon-Borne Observations of Arctic Low Cloud Properties**
Gunho Oh (Korea Polar Research Institute)

P1 07 **Possible Link Between Barents-Kara Sea Ice and PM10 concentration in South Korea during January**
Jeong-Hun Kim (Kongju National University, Korea Polar Research Institute)

P1 08 **Enhanced carbon emission at moist tundra due to increased respiration under warming environment**
Ji Yeon Lee (Korea Polar Research Institute)

P1 09 **Variability of sea surface salinity in the Nordic Sea**
Ji-Eun Park (Korea Polar Research Institute)

P1 10 **Impact of Antarctic meltwater forcing on East Asian climate under greenhouse warming**
Ji-Hoon Oh (Pohang University of Science and Technology)

P1 11 **Long-term change and impact analysis of net radiation over Arctic**
Minji Seo (Korea Polar Research Institute)

P1 12 **Biological carbon pump processes in the sea ice-affected region of Antarctica**
Minkyoung Kim (Seoul National University)

P1 13 **Carbon dioxide and methane fluxes measurement near tundra ponds ecosystems in Cambridge Bay, Canada**
Namyi Chae (Korea University)

P1 14 **Assessment of radiative forcing with sea ice changes over arctic using radiative kernels**
Nohhun Seong (Pukyong National University)

Session 2 _ Cryosphere evolution and sea-level change

Online

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Chris Pierce (Montana State University)

P2 02 **Autonomous Underwater Glider Observations of Eddy-Driven Transport at the Edge of the Nansen Ice Shelf**
Drew Friedrichs (University of California, Davis)

P2 03 **Changes of Campbell Glacier Tongue in East Antarctica observed with satellite SAR**
Hyangsun Han (Kangwon National University)

P2 04 **Changes in the relative sea-level (RSL) of the Gulf of Dvina (White Sea, north-western Russia)**
Iurii Kublitckii (Herzen State Pedagogical University of Russia)

P2 05 **Multi-layer structures of meltwater plume near grounding line, Antarctica**
Jisung Na (Korea Polar Research Institute)

P2 07 **Subglacial morphology and hydrology in the 60E – 100E coastal sector of East Antarctica**
Sergey Popov (Polar Marine Geosurvey Expedition)

P2 08 **A high-resolution process study of High Salinity Shelf Water formation in the Terra Nova Bay Polynya, Ross Sea, Antarctica**
Una Miller (Columbia University)

P2 09 **An east-west contrasting salinity change of Antarctic Bottom Water in the Indian sector of Southern Ocean over recent decades**
Yeon Choi (Seoul National University)

Session 3 _ Sea ice and polar oceans in rapid transition

Online

P3 02 **Autonomous zooplankton profiler reveals the changing dynamics of zooplankton during a summer-winter-summer transition in the very high-Arctic**
Jeremy Wilkinson (British Antarctic Survey)

P3 03 **Is the Primary Production in the Antarctic polynya system declining?**
Jinku Park (Korea Polar Research Institute)

P3 04 **Estimation of Arctic basin-scale total freeboard from passive microwave satellite**
Jong-Min Kim (Korea Polar Research Institute)

P3 06 **Flexural Strength of the Arctic Sea Ice: A Case Study in the Barents Sea**
Seung Hee Kim (Korea Polar Research Institute)

P3 07 **Spatial distribution of krill(Euphausia superba and E.crystallorophias) in the Terra Nova Bay polaynya and Ross Sea polynya during summer 2020**
Wuju Son (Korea Polar Research Institute)

P3 08 **Seasonal Variability of Minimum Brightness Temperature at the 6.925 GHz Band of AMSR2 for the polar Oceans**
Young-Joo Kwon (Korea Polar Research Institute)

P3 09 **The Response of the Nordic Seas to Wintertime Sea-ice Retreat**
Yue Wu (University of East Anglia)

Session 4 _ Technological advances enabling new polar science

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Bimochan Niraula (Alfred Wegener Institute)

P4 02 **Development of an Unmanned Ground Vehicle for Detecting Hidden Crevasses**
Changhyun Chung (Korea Polar Research Institute)

P4 03 **Spatial and Regional Intercomparision of the Total Ozone Column in Antarctica Continent based on Ground and Satellite-based Observations**
Songkang Kim (Yonsei University)

P4 06 **Decomposition of water dissolved organic pollutants using freezing activated HCO3−/ PMS system**
Yong-Yoon Ahn (Korea Polar Research Institute)

Session 5 _ Integrated study of subglacial Antarctic lake ecosystems Online

P5 01 **Bacterial Community Structure of Surface Snow in Antarctica**
Ahnna Cho (Korea Polar Research Institute)

P5 02 **Mathematical modelling of the rapid draining of lakes and the formation of an ice depression on Dålk Glacier (Larsemann Hills, East Antarctica)**
Alina Boronina (State Hydrological Institute, Saint Petersburg State University)

P5 03 **Effect of Antifreeze Proteins from the Arctic Yeast Leucosporidium sp.AY30 on Freezing-enhanced Oxidation of Iodide by Hydrogen Peroxide**
Bomi Kim (Korea Polar Research Institute)

P5 04 **Rigidity condition for the hyper-activity of ice binding protein and implication for polar microbial survival**
Hackwon Do (Korea Polar Research Institute)

P5 05 **Study on the impact of climate change on Antarctic plant-pathogen interactions**
Hongshi Jin (Korea Polar Research Institute)

P5 06 **Classification of behaviors of South polar skua (Stercorarius mccormicki) breeders using acceleration and video data**
Hyunjae Chung (Korea Polar Research Institute)

P5 07 **Soil microbiome in permafrost soils of Eastern Antarctica: functional and structural diversity, environmental factors**
Ivan Alekseev (Arctic and Antarctic Research Institute, Saint Petersburg State University)

P5 08 **Characterization of novel polyethylene terephthalate-degrading enzyme (PETase) from the polar bacterium**
Jihyeon Yu (Korea Polar Research Institute)

P5 10 **Structural and sequence comparisons of bacterial enoyl-CoA isomerase and enoyl-CoA hydratase**
Jisub Hwang (Korea Polar Research Institute)

P5 11 **Gut microbiota and diet composition of Muskox (Ovibos moschatus) by age using fecal and stable isotope analysis**
Ji-Yeon Cheon (Korea Polar Research Institute)

P5 12 **Ship noise effects on an Antarctic seal**
Jongchan Lee (Korea Polar Research Institute)

P5 13 **Recolonization of Adélie penguins (Pygoscelis adeliae) at Cape Hallett on Ross Sea, Antarctica**
Jong-U Kim (Korea Polar Research Institute)

P5 14 **Soil microbial co-occurrence network became less connected with the soil development along the glacier foreland of Midtre Lovénbreen, Svalbard**
Ke Dong (Kyonggi University)

P5 15 **Changes in Meso-and Macro-zooplankton communities along the Northern Antarctic Peninsula (Summer 2019-2020)**
Maria Isabel Criales-Hernandez (Universidad Industrial de Santander)

P5 16 **Prospect of HSP70 in Glaciozyma antarctica as biomarkers under climate change scenario**
Nur Athirah Yusof (Biotechnology Research Institute, Universiti Malaysia Sabah)

P5 17 **Polar Microalgae Project: understanding of species-specific ecophysiological responses to recent climate changes at the phenotypic and genetic levels**
Sung Mi Cho (Korea Polar Research Institute)

P5 18 **Mare incognita: Adélie penguins foraging in newly exposed habitat after calving of the Nansen Ice Shelf**
Won Young Lee (Korea Polar Research Institute)

P5 19 **Microbial community structure across the environmental gradients and physiological characteristics of culturable bacteria in the East Siberian Sea**
Yerin Park (Korea Polar Research Institute)

P5 20 **Dietary niche partitioning in Brown skuas (Stercorarius lonnbergi) during the chick-rearing period at Narębski Point on King George Island, Antarctica**
Youmin Kim (Korea Polar Research Institute)

P5 21 **Investigation of intertidal macroalgal distribution and biomass using UAV in Barton Peninsula, King George Island, Antarctica**
Young Wook Ko (Korea Polar Research Institute)

Plenary Lecture 1 Sep. 28 09:30-10:00

High-resolution climate modelling from a polar perspective

Thomas Jung

Alfred Wegener Institute for Polar and Marine Research, Germany

Biography

Thomas Jung works at the Alfred Wegener Institute, Helmholtz Centre for Polar and Marine Research in Germany. He has received his PhD in atmospheric physics from University of Kiel and the Institute for Marine Research (now GEOMAR). He then went on to work for 10 years in the Research Department of the European Centre for Medium-Range Weather Forecasts (ECMWF) in the UK. Thomas is head of the Climate Dynamics section at AWI and full professor for physics of the climate system at the University of Bremen. He is also spokesperson of AWI's research programme. Furthermore, he acts as the chair of various committees, including the Polar Prediction Project of the World Meteorological Organization. Thomas coordinates major research projects such as APPLICATE, which is funded through the Horizon2020 program, and Advanced Earth System Modelling Capacity, which is funded through the Helmholtz Association.

Abstracts

In this presentation, I will give an overview of some major ongoing and emerging developments in high-resolution global climate modelling, with an emphasis on polar regions. It is argued that sea ice-ocean models on unstructured meshes represent promising new tools that benefit from mesh flexibility and high scalability on existing and upcoming HPC systems. This point is illustrated by means of high-resolution climate simulations that suggest that the Antarctic sea ice paradox (i.e., Antarctic sea ice cover is not shrinking in an otherwise warming word) can be explained by meso-scale processes in the Southern Ocean. Furthermore, it is shown that km-scale simulations with sea ice-ocean models are capable of simulating realistic linear kinematic features of sea ice such as leads when compared to satellite data. However, for this to work effectively, changes to the numerics of sea ice are needed. The new capabilities will allow to determine the climate relevance of sea ice leads.

The Thwaites-Amundsen ice-ocean system: current results from the International Thwaites Glacier Collaboration

Ted Scambos

University of Colorado Boulder, U.S.A.

Biography

Ted Scambos is a Lead Principal Investigator of the Science Coordination Office for the International Thwaites Glacier Collaboration, and a member of the US Polar Research Board, the USGS Landsat Science Team, and is a research faculty member of the Earth Science Observation Center at the University of Colorado Boulder. Dr. Scambos received a Ph.D. in Geoscience in 1991. He has been on 21 expeditions to Antarctica, studying its ice shelves, ice streams, sea ice, and icebergs. He has discussed climate change in the polar regions in numerous interviews for print, radio, and television media.

Abstracts

The International Thwaites Glacier Collaboration (ITGC) is a joint US-UK Antarctic multi-disciplinary program consisting of eight research projects and a science coordination office, with additional collaborations from Germany, Sweden, and South Korea. The program began in 2018 and will extend past 2023. It includes several field expeditions and research cruises, and modeling studies of processes within the glacier system as well as near-term (decade- to century-scale) forecasts of glacier mass balance. Key results of the research to date include: improved mapping of the seabed and sub-glacial bed; tracking of the water masses near the ice front, beneath the ice shelf, and at the grounding line areas; new and more detailed models of how marine ice cliff instability and marine ice sheet instability might unfold for Thwaites Glacier in the coming decades; assessments of the recent evolution and approaching demise of the remaining ice shelf; and remote-sensing-based studies of grounding line retreat and sub-glacial lake drainage events. Additionally, the ITGC community has taken a pro-active stance on issues of justice, equity, diversity, and inclusivity, and has made early-career researcher development a priority for the program. A review of the importance of Thwaites Glacier to the stability of the West Antarctic Ice Sheet, the causes of the ongoing retreat and acceleration, the structure of the program, and the results to date will be presented.

Arctic PASSION - a new 4-year program to advance a pan Arctic Observing System in support of societal needs

Michael Karcher

Alfred Wegener Institute for Polar and Marine Research, Germany

Biography

Michael Karcher is a senior scientist working in the Sea Ice Physics section at the Alfred Wegener Institute for Polar and Marine Research in Bremerhaven, Germany. His scientific background is in physical oceanography, and he has been working in numerous international and national projects with a focus on the circulation of the Arctic Ocean and the coupled sea ice-ocean system of the Arctic. He has also been active in interdisciplinary and cross-sectoral projects. Michael is chair of the Arctic/Subarctic Ocean Flux Study – ASOF and the scientific coordinator of the H2020 EU project Arctic PASSION (Pan-Arctic Observing System of Systems - Implementing Observations for Societal Needs).

Abstracts

The Arctic is more affected by climate warming than any other region. To monitor the ongoing changes, to better predict the evolution of climate system and to develop mitigation measures, we need a coherent system of Earth Observations. Whilst much progress has been made over the previous years, the current observational system is still fragmented, inaccessible, and not necessarily tuned to user needs.

Working collaboratively with European and international partners, Arctic PASSION, a new €15million, 4-year program funded by the European Commission, aims to address these fundamental flaws to co-create a more coherent and better integrated pan-Arctic Observing System of Systems (pan-AOSS). To do this, Arctic PASSION sets out to:

- Improve marine, terrestrial and atmospheric observing system elements and services by enhancement, better integration, and increased functionality of existing and new observing components and new pilot services;
- Assess societal needs and quantify benefits connected to an improved, user-driven observing system;
- Better address the observational needs of people living in the Arctic, in particular to expand monitoring capabilities through broad inclusion of Indigenous Knowledge and Local Knowledge;
- Improve data interoperability, and access to 'application-ready' environmental data for all users, with a focus on enhancing access to observations that have relevance to Arctic, European and global society;
- Empower the private sector, policymakers, and civil society with critical tools necessary to observe, better understand and predict future change in the Arctic environment, over different spatial and time scales;
- Coordinate and cooperate internationally with Arctic programs performed by Arctic and non-Arctic nations alike.

To initiate a discussion on the best ways to integrate and cooperate with the Korean Arctic research we will provide an overview of Arctic PASSION, its work package structure and its planned activities.

Engineering and Science Support for U.S. Antarctic Program

Rosa Affleck

Cold Regions Research and Engineering Laboratory, U.S.A.

Biography

Dr. Rosa Affleck works at the Cold Regions Research and Engineering Laboratory in Hanover, New Hampshire since 1994 as a civilian employee. Her work deals with interdisciplinary research through modeling, experiment, and measurements involving sustainability and capacity of infrastructure or system (i.e., facilities, pavements, drainage, and vehicle mobility) that affect operations. Also, her recent research initiative integrates field observations of social data and geospatial information by applying mixed-methods and creating models to relate community resiliency and sustainability of infrastructure. She has authored close to 100 technical publications, collaborated with stakeholders and colleagues, mentored students and junior staff, chaired sessions at conferences, and gave presentations at technical meetings. She also manages a program supported by a team of scientists and engineers from CRREL for providing engineering and research support to the U.S. Antarctic Program (USAP) to develop infrastructure and logistics solutions. Solutions include developing new, more efficient, and safer means to transport material by air and ground, and logistics assets such as runway, snow road, fuel and cargo traverses from McMurdo Station to South Pole Station, traverse route assessment, sled for resupply, ice pier, building and utilities improvements, and geotechnical information.

Abstracts

Operations in Antarctica require vital infrastructure and resources in austere environments and extremely cold with hazardous conditions to support US research and activities in Antarctic, including sustainment of the politically invaluable US station at the geographic South Pole. Scientists and engineers from the Cold Regions Research and Engineering Laboratory (CRREL) provide engineering and research support to the U.S. Antarctic Program (USAP) to address these difficulties through field experience, measurements, and modeling. Solutions include developing new, more efficient, and safer means to transport material by air and ground, and logistics assets such as runway, snow road, fuel and cargo traverses from McMurdo Station to South Pole Station, traverse route assessment, sled for resupply, ice pier, and installation improvement. This talk provides the synopsis of various CRREL's efforts pertaining to building, utilities, and overall installation improvement. Installations built on ice, permafrost, or seasonal frozen ground require careful design to avoid melting issues. Efforts to rebuild McMurdo Station to improve operational efficiency and consolidate energy resources required knowledge of geology and geotechnical information, particularly soil indices within the near-surface layer subjected to temporal fluctuations and the ice-cemented layer knowledge of near-surface geology using geophysical and geotechnical methods. Investigation on building efficiency was a survey effort to produce a three-dimensional (3-D) model with assigned temperature values for target surfaces, useful in spatially identifying thermal anomalies and areas for building envelope and wet utilidor. Other efforts for modeling included assessment of drifting and snow deposition to examine the impact of lifting the elevated South Pole Station on snow drift accumulation on nearby facilities. Results of these efforts are insightful for USAP master plan to modernize and update with energy-efficient facilities as well as for maintenance of facilities on the existing footprint.

A new airborne ultra-wideband radar system for polar surveys

Drew Taylor

Remote Sensing Center, University of Alabama, U.S.A.

Biography

Drew Taylor received the B.S. and M.S. degrees in Electrical Engineering from the University of Alabama, Tuscaloosa, AL, USA, in 2008 and 2011, respectively, and the Ph.D. degree in Electrical and Computer Engineering form Mississippi State University, Mississippi State, MS, USA, in 2018. He is currently an Assistant Professor of Electrical and Computer Engineering in the Department of Electrical and Computer Engineering and also with the Remote Sensing Center, University of Alabama, Tuscaloosa, AL, USA. His research interests include digital and embedded systems, radar signal processing, and remote sensing of the earth.

Abstracts

The University of Alabama (UA) and the Korea Polar Research Institute (KOPRI) are developing an ultra-wideband (UWB) radar with a large-antenna array for the airborne sounding and imaging of glaciers and ice sheets in the polar regions. We are developing this UWB radar to sound about 5-km thick ice in Antarctica and image an ice-bed interface covered with 1-5 km thick ice over a wide swath of 1-2 km. We have designed the radar to map internal layers close to the bed with return loss of about 90 dB or more with fine resolution of about 50 cm. The UWB radar will operate over the frequency range of 170-470 MHz and it is being developed with a loop sensitivity of about 261 dB. It will be one of the most powerful and sensitive radar systems in the World. The design uses a sixteen-element antenna array underneath each wing of a DHC-6 Twin Otter aircraft, with one subarray used both for transmit and receive using transmit/receive (T/R) switches, and the other used only for receive. We will form 8 T/R sub-arrays and 8 receive sub-arrays using passive power combiners. Each T/R sub-array will be supplied with a chirped transmit signal of 1 us or 10 us duration with peak power of 200 W at a pulse repetition frequency of 5 or 10 kHz. The 1-us pulse is for sounding ice and mapping internal layers to a depth of about 1 km, and the 10-us pulse is for sounding thick ice of 1 km or more and mapping deeper layers. In addition to the hardware of the system, a new software processing suite has been developed to optimally process and enhance very deep layers. The processor has been tested on multiple older ice sounder datasets, the results of which will be presented during this address. Using the newly developed radar system and processor, an airborne campaign will be carried out over the Antarctic ice sheet in the coming years to generate a 3-D topographic map of the ice-bed. This talk will introduce this collaborative project and the radar system being developed. The radar system design and its capabilities will be discussed in this presentation. It will also include results from advanced signal processing algorithms on previous data sets.

Antarctic Subglacial Lakes: Oases for Life in a Polar Desert

John C. Priscu

Montana State University, U.S.A.

Biography

John Priscu is a Regents Professor of Ecology at Montana State University. He has spent 36 field seasons in Antarctica conducting research on life under ice-shelves, the Southern Ocean, sea ice, permanently ice-covered lakes, and life beneath the Antarctic ice sheet. He is a Fellow of the American Society of Limnology and Oceanography, American Association for the Advancement of Science, and the American Geophysical Union, is a German Humboldt Scholar, and has received numerous awards for his research, including a valley and a stream in Antarctica named in his honor, the Goldwaithe Medal in Glaciology for his work on polar ice sheets, the International Medal for Scientific Excellence from the Scientific Committee on Antarctic Research, and the E.O. Wilson Biodiversity Award for his work on microbial dynamics in polar lakes and ice cores. Priscu has published more than 300 scholarly articles on his research and edited 4 books.

Abstracts

The Antarctic subglacial environment is one of the least explored regions on Earth. Information about the nature of this environment obtained using clean drilling technology has transformed the way we view the continent and extended the bounds of our biosphere. Direct sampling of subglacial lakes beneath the Whillans and Mercer Ice Streams has revealed that they harbor thriving ecosystems consisting of diverse and abundant populations of microorganisms. We are just beginning to understand the role these subglacial ecosystems play in biogeochemical processes on both local and global scales. The interdisciplinary study of subglacial environments has also shown that these lakes and associated water-saturated sediments have important roles in ice stream dynamics and mass balance, and yield novel climatic information. I will provide an overview of key discoveries of the biogeophysical nature of Antarctic subglacial environments and how they have transformed our view of Antarctica, and propose a path for future interdisciplinary research on subglacial lake ecosystems on the Antarctic continent.

Oral Presentation | S1 01

Atmospheric circulation response to the recent winter Arctic sea ice decline: A weather-scale model experiment

Heeje Cho

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ABSTRACT

Over the last few decades, there have been notable changes in the wintertime Arctic atmospheric circulation, possibly connected to the increased occurrence of extreme weather in the Northern Hemisphere midlatitudes. However, how recent Arctic sea ice decline is related to the atmospheric circulation is still under debate. In this study, to assess immediate atmospheric responses to the Arctic sea ice decline, an ensemble of short (< 6 days) weather forecast-type simulations are performed using a regional model (The polar-optimized version of the Weather Research and Forecasting) forced by the winter mean sea-ice concentration change. The model results show that the sea ice decline causes a significant change in the atmospheric circulation by local increases of atmospheric pressure. Furthermore, we demonstrate here that the response to the sea-ice change highly depends on background flow, that is, the responses are distinctively higher (about 10 times) for low-pressure (cyclonic) weather systems than for highpressure (anticyclone) weather systems. It is suggested that more turbulent heat flux and weak static stability under the low-pressure systems lead to a stronger vertical heat flux, which induces stronger atmospheric responses to the sea-ice boundary forcing. Our result implies that, as the Arctic surface warming continues in the future, the near-surface atmosphere will be more unstable, consequently, the Arctic atmospheric circulation will be more sensitive to sea ice changes.

Oral Presentation | S1 02

Recent weakening of the southern stratospheric polar vortex and its impact on the surface climate over Antarctica

Hataek Kwon

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ABSTRACT

The variability in the southern stratospheric polar vortex (SSPV) and its downward coupling with the troposphere is known to play a crucial role in driving climate variability over Antarctica. In this study, SSPV weakening events and their impacts on the surface climate of Antarctica are examined using in-situ observation and reanalysis data. Combining criteria from several previous studies, we introduce a new detection method for SSPV weakening events. Based on the new criteria, the occurrence frequency of SSPV weakening events has exhibited a systematic increasing trend since the 2000 s. However, the weakened anomalies of individual SSPV events are not statistically different (95% confidence level) between the earlier (1979–1999) and later (2000–2017) periods examined in this study. The recent increase in the occurrence of SSPV weakening events is largely controlled by tropospheric mechanisms, i.e. the poleward heat flux carried by southern hemispheric planetary waves and associated vertical wave propagation. Among the various scales of planetary waves, the wavenumber 1 contributes most of the poleward eddy heat flux. We show that SSPV weakening events induce statistically significant cooling over the Antarctic Peninsula (AP) region and warming over the rest of Antarctica. Typically, surface air temperature anomalies with large negative values smaller than − 0.6 ◦C and positive values larger than + 0.8 ◦C are observed over the east coast of the tip of the AP and King Edward VII Land, respectively. The influence of an SSPV weakening event on the surface lasts for approximately three months with higher height anomalies off western Antarctica, providing favorable conditions for the atmosphere to transport cold air from the interior of Antarctica to the AP via the Weddell Sea. Distinct positive surface air temperature anomalies over the rest of Antarctica are associated with the northerly circulation anomaly from the eastern Weddell Sea to east Antarctica.

Oral Presentation | S1 03

Lightning occurrence observation using electromagnetic field measurement surrounding Antarctica Peninsula

Sulaiman Ali Mohammad

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ABSTRACT

A lightning measurement system was successfully installed in King Sejong Station in King George Island, Antarctica to observe lightning occurrence in polar region. The lightning sensors consist of fast electric field sensor that operated between few hertz to 1 MHz and slow electric field sensor that operated less than 100 Hz. Both sensors used parallel plate antennas accompanied with their respective buffer circuit. A magnetic field sensor was also deployed with two orthogonal loops antennas that operates between 400 Hz to 400kHz to capture the magnetic field radiated from the lightning that occurred in the polar region. The lightning data were collected between 11th and 31st January 2020. The observation of cloud-to-ground (CG) flashes detected surrounding Antarctica Peninsular could be observed from 20 storms that have been identified with a total of 166 CG flashes detected. From the total CG, 102 were identified as negative CG flashes while 64 were identified as positive CG flashes. Using the magnetic direction finder (MDF) method, the lightning locations were obtained when the peak of the return strokes of electric and magnetic fields reading were taken. Based on the calculation and magnetic field factor correction (B-Factor), the distance was obtained from the Matlab and input to the Google Earth for easy observation. Using the MDF method, the area surrounding the sensor's location is divided into four quadrants namely Q1, Q2, Q3 and Q4 where lighting location will be located based on the flash types and polarity of signals in magnetic field waveforms. For positive CG flashes, there were 53 flash located at Q1 while 11 flash were located at Q4. For negative CG flashes, 86 flashes were in Q1 while 16 flashes were in Q4.

Oral Presentation | S1 04

Formation of marine secondary aerosols in the Southern Ocean, Antarctica

Shanshan Wang

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ABSTRACT

Water soluble ions (WSIIs) in aerosols especially marine secondary aerosols could participates in the formation of cloud condensation nuclei (CCN) in the marine boundary layer and affect the global climate. However, there is still a lack of studies on the background concentrations and the generation and extinction mechanisms of marine secondary aerosols in polar areas. High time resolution concentrations of WSIIs in aerosols were collected and analyzed by an in-situ gas and aerosol composition monitoring system in Southern Ocean (SO) to identify the formation of marine secondary aerosols including methanesulfonic acid (MSA), SO42-, and NO3-. Average hourly mass concentrations of WSIIs was 663.01 ng/m3 and the secondary aerosols accounted for 49.78±20.20% in WSIIs. SO42- and NO3- was mainly formed by the homogeneous reaction, whereas homogeneous and heterogeneous reactions together contributed to the formation of MSA in marine aerosols. The melting of sea ice and the increase of chlorophyll-a concentrations led to the increase of MSA concentrations in marine aerosols in SO. In the range of -2.5 ℃ to 0℃ in SO, the increase of temperature contributed to the formation of NO3- but inhibited the formation of SO42- in marine aerosols. MSA-Na, MSA-NH4+, MSA-SO42-, MSA-Mg, MSA-K, and MSA-Cl were existed in marine aerosols in SO. Main existence forms of SO42- and NO3- were NH4NO3, (NH4)2SO4, as well as Na2SO4, MgSO4. The results enriched the background data of WSIIs in marine aerosols in SO, and provided the theoretical support for coping with global climate change. Keywords: water soluble ion, marine secondary aerosol, formation, existence form, Southern Ocean.

Oral Presentation | S1 05

Spatio-temporal variations of Black Carbon over Arctic in a regional climate model

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ABSTRACT

Aerosols and their interactions with the cryosphere, clouds, and sea can have a significant impact on radiation balance in the Arctic. Aerosols likely account for 45% or more of the warming that has occurred in the Arctic during the last three decades. The absorbing aerosol (e.g., black carbon) deposited over the snow-covered surface has a considerable influence on snow albedo. BC aerosols are mainly produced by biomass burning and combustion of fossil fuels. BC mass concentrations are simulated using Weather Research and Forecasting with Chemistry (WRF-CHEM) model over the Arctic region during the boreal winter (December– January–February) and summer (June–July–August–September) seasons of the year 2018. WRFCHEM is able to simulate spatial and seasonal variations in near-surface temperature and relative humidity (RH). BC masses are ranging from 5–20 ng m−3 over most parts of the Arctic in boreal winter, while BC values are double in summer. Siberian and Canadian regions show higher BC mass (> 30 ng m−3), which could be due to the fire activities in these regions. The fire events in the western part of the Arctic could not influence the major area, while fires in the Siberian region have affected a much larger part of the Arctic as the winds are mostly from east to west in winter. The increased amount of BC present over the Arctic area has a substantial influence on the Earth's radiation budget and can dramatically alter the albedo of sea ice in the region. This can affect the Arctic climate in particular and global climate in general. The outcome of the study will be helpful in improving our understanding of spatial and vertical variations of BC in the Arctic which will further useful in improving the model prediction of climate.

Oral Presentation | S2 01

Investigating the role of Marine Ice Cliff Instability in the Amundsen Sea Sector over the next century

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ABSTRACT

Marine Ice Cliff Instability (MICI) has been a controversial topic ever since it has been introduced about a decade ago. This physical process could be triggered if tall ice cliffs are exposed after the collapse of floating extensions. While we have not found clear evidence of MICI related instability in the observational record, it could potentially accelerate the retreat of marine terminating glaciers, thereby increasing the contribution of West Antarctica dramatically. It is therefore critical to investigate its potential role in this sector of Antarctica using high-resolution numerical models. We implement here a new parameterization based on high-resolution 3D models combining a full-Stokes continuum model and two implementations of the Helsinki Discrete Element Model (HiDEM) that was published earlier this year. This parameterization is tested with several friction laws and different resolutions over the entire Amundsen Sea. We find that, while Thwaites Glacier is relatively insensitive to the Marine Ice Cliff Instability, Pine Island could collapse rapidly inland if its ice shelf were to collapse.

Oral Presentation | S2 02

Repeat radar survey and basal evolution of Thwaites Glacier, West Antarctica.

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ABSTRACT

The evolution of the Thwaites Glacier has been of significant scientific importance as the glacier's impact on near term sea level rise is investigated. The glacier's demonstrated sensitivity to forcing, primarily from the ocean, has made it an indicator of ice sheet instability. The glacier's subglacial hydrology and geological setting are thought to be important controls on the rapid changes this glacier is experienced. Radar observations of this region extend back to 2004 with a survey conducted by University of Texas - Institute for Geophysics, and has been used to describe the glacier's subglacial hydrological state. New radar observations collected in 2020 as part of LIONESS-TG used a system that is a direct descendant of the 2004 system. Numerous ground tracks collected in 2004 were re-surveyed again in 2020 for the express purpose of investigating basal evolution. We will present how subglacial and englacial conditions have changed over the 16 year period and how that relates of observed changes in ice geometry, grounding zone, and ice flow.

Oral Presentation | S2 03

Pathways and heat transports of Circumpolar Deep Water into the Thwaites and Pine Island Glaciers, West Antarctica

HyungBo Kim

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ABSTRACT

It is known that upwelling Circumpolar Deep Water (CDW) is destabilizing Western Antarctic ice shelves — Thwaites and Pine Island ice shelves — and accelerating basal melting by delivering warm water underneath the ice shelves, which can significantly contribute to future sea-level rise. Its detailed pathways, however, into the two ice shelves and modification of its property remain unclear primarily due to a lack of in-situ observation in a necessary resolution. Here, we present detailed pathways and heat transports of CDW by analyzing hydrographic and current data collected using the Korea Polar Research Institute Icebreaker ARAON-based CTD/LADCP castings off the ice shelves and University of Tasmania Autonomous Underwater Vehicle (AUV; nupiri muka)-based CTD/ADCP measurements under the sea ice during 2019-2020 cruise. We confirmed a general poleward pathway of warm and saline CDW into the ice shelves that are mostly following deep (> 660 m or neutral density of 28.03 kg/m3) troughs, which is basically in an agreement with previous results suggested by a regional ocean circulation model. However, detailed pathways are far different from what has been recognized previously, yielding a block from direct penetration toward the Pine Island ice shelf but detouring toward the Thwaites ice shelf, with relatively high (> 1.067 ℃) water temperature observed in troughs closer to the Thwaites ice shelf. The observational results show 1) poleward and equatorward flows of CDW within the eastern and western sides of one narrow trough (width of ~5 km) off the sea ice, 2) poleward flow with a narrow width of ~ 6 km in the western side of another trough below the sea ice, and 3) oppositely directed deep flows (inflow and outflow in the upper and lower levels) within a trough. Total amounts of heat transport into the Thwaites and Pine Island ice shelves are estimated to 2.09±0.52 and 1.02±0.19 TW, respectively, which may help to constrain model's basal melt rates and prediction on the future sea level changes. Our study provides detailed information on the pathways and heat transports of CDW, ultimately allowing us to better predict a tipping point or timing of collapse of the glaciers.

Oral Presentation | S2 04

Holocene relative changes in the White Sea level according to paleolimnological data

Dmitriy Subetto

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ABSTRACT

Lake bottom sediments, among other geological archives, are chronicles that record and preserve information about past natural and climatic conditions at the regional and planetary level with a resolution from millennia and centuries to a year. In recent years, there has been a significant increase in interest in paleolimnological research in the Northern Hemisphere, which is primarily caused by the problem of global climate change, especially in high latitudes. In the circumpolar regions of the Northern Hemisphere, there are a huge number of lakes of various genesis and morphometry, which have archived in their bottom sediments detailed information about changes in climate, landscapes and hydrology in the Pleistocene and Holocene. Since 2005, paleolimnological studies have been conducted in the Solovetsky Archipelago, and since 2014, these studies have been initiated on the Onega Peninsula of the White Sea in order to reconstruct the dynamics of the relative level of the White Sea in the Holocene. In the Solovetsky Archipelago, several lakes were explored at different absolute levels. Lake Isakovskoe (3 m asl) at the early stage of the its development was as a part of a White Sea bay, which characterized by active hydrodynamics, as indicated by the coarser lithological composition of sediments and the presence of diatoms of the pelagic species Porosira glacialis and Thalassiosira excentrica. Lake Svyatoe (8 m asl)was isolated about 2715 14C years ago. Lake Isakovskoye was isolated from the sea between 2040 and 1530 14C years ago. The results of radiocarbon dating of the sediments of Lakes Bolshoe and Verkhneye Zelenoe indicate that the accumulation of lake sediments occurred continuously throughout almost the entire Holocene and, consequently, the water level of the White Sea was below the modern 35-meter mark. In 2014, field paleolimnological studies were conducted on two sites of the Onega Peninsula. In the southwestern part of the peninsula, Lake Pertozero (11,6 m asl) was studied. In the lower part of the column of bottom sediments, gray varved clay, presumably formed in a preglacial lake, was uncovered and passed through, in the upper part – various types of gyttja (lacustrine and marine sediments). In the north-west of the Onega Peninsula, 4 lakes were studied: Kamennoe (26.2 m asl), Srednoye (17.1 m asl), Lake without a name (16 m asl) and Konyukhovskoye (15.8 m asl). In these lakes deposits of limno-glacial, lacustrine and marine origin were found, which in turn allowed us to perform a preliminary reconstruction of the flooded areas of the peninsula during the maximum rise of the White Sea water in the Holocene. Complex paleolimnological studies allowed us to reconstruct the dynamics of changes in the relative sea level in the Holocene. Acknowledgements
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Oral Presentation | S2 05

Polynya Preconditioning: Ocean Processes South of the Drygalski Ice Tongue, Western Ross Sea

Craig Stevens

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ABSTRACT

We describe hydrographic mooring timeseries data from a location just to the south of the Drygalski Ice Tongue at the southern boundary of the Terra Nova Bay Polynya. The undersampled region is where the northward flowing Victoria Land Coastal Current encounters the ice tongue. The mooring was deployed in Geikie Inlet through all of 2017 for two years and was coupled with several contemporaneous oceanographic moorings to the north of the Drygalski Ice Tongue. Temperature and salinity are consistent north and south of the ice tongue. Some transients are observed on both sides, albeit with a of lag of ~12 days in both Temperature and Salinity (but at different times). The region is subject to katabatic winds however the polynya to the south of the DIT operates at different times through the annual cycle to the TNB Polynya as the sea ice in the region is far more constrained in its motion. Temperature and salinity conditions observed cover a wide range but do include that expected in a Ross Ice Shelf outflow signature.

Oral Presentation | S2 06

Antarctic ice mass change (2003-2016) jointly estimated by satellite gravimetry and altimetry

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ABSTRACT

Accurate estimation of ongoing Antarctic ice mass change is important to predict future ice mass loss and subsequent sea-level rise. Over the past two decades, Antarctic ice mass changes have been observed by the Gravity Recovery and Climate Experiment (GRACE) gravity mission, but the low spatial resolution of GRACE (~300 km) has limited understanding of glacier-scale contributions. In this study, we combine GRACE and altimetry data to obtain mass change estimates with a greatly improved spatial resolution (~30km). Combined estimates are obtained by a constrained linear deconvolution (CLD) algorithm used in a previous GRACE study. Satellite altimetry observations are introduced as an a priori, and resulting estimates retain the high spatial resolution of satellite altimetry, but when smoothed agree with low-resolution GRACE data. These glacial-scale estimates also agree with ice budget calculations using the InputOutput method.

Oral Presentation | S3 01

Intensified Arctic Cyclone Activities and Observed Driving Mechanisms for Accelerating Summer Sea Ice Decrease

Xiangdong Zhang

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ABSTRACT

Along with long-term trend of intensification of Arctic cyclone activities, strikingly strong cyclones have more frequently occurred during recent decade. In particular, following these strong cyclone events, low minima of summer sea ice extent have been observed. Both of these raised a scientific question how strong cyclones drive changes in Arctic climate system, influence atmosphere-sea ice-ocean interactions, and, in turn, cause extreme sea ice decrease. However, it is really challenging to answer this question due to rare field observations of Arctic cyclones and associated physical processes, as well as discrepancies in high resolution Arctic sea ice and ocean modeling. In this study, we address this problem by analyzing in-situ observations acquired during an Arctic expedition, which uniquely captured a strong cyclone in summer 2016. The result shows a pronounced acceleration of sea ice area decrease during the cyclone process at a rate about 5.7 times the climatological mean in the Pacific Arctic Ocean. The decreased sea ice area within the study domain disproportionally contributed to about 43% of totally decreased sea ice area in the entire Arctic Ocean, although the sea ice area within the study domain is only about 14% of the total sea ice area. Diagnostic analysis indicates a net heat energy loss at the sea ice surface, obviously not supporting the accelerated sea ice melt. Although the open water surface gained net heat energy, it was insufficient to increase the mixed-layer temperature to the observed values by Conductivity-Temperature-Depth (CTD) instrument. Dynamic analysis suggests that cyclone-driven increase in ocean mixing and upward Ekman pumping of the Pacific-origin warm water tremendously enhanced oceanic heat flux. The thermal advection by the Ekman pumping led to a warmed mixed layer by 0.05~0.12 oC and, as a consequence, an increased basal sea ice melt rate by 0.1~1.7 cm day-1.

Oral Presentation | S3 03

A remote sensing approach to estimate under-ice light and algal bloom onset on a pan-Arctic scale

Gaëlle Veyssiere

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ABSTRACT

The unprecedented warming of the Arctic region has strong impacts on the sea-ice cover. In particular the thick multi-year ice that predominately covered the Arctic Ocean has been replaced by a regime controlled by thinner, more dynamic, first-year ice. These fundamental changes in the sea ice scape influence the under-ice light field, which is one of the main drivers of ecosystem structure and biogeochemical functioning within the Arctic marine environment. Spatial and temporal observations of the biological response to these changes are crucial but remain challenging to conduct over large spatial scales. In this study, we focus on measurements performed during the leg 4 of the Multidisciplinary drifting Observatory for the study of Arctic Climate (MOSAiC) expedition in the Central Arctic Ocean. We developed a normalized difference index (NDI) algorithm based on under-ice light and chl a measurements performed over various sea ice types and conditions during summer. We will present results from the application of this NDI to different platforms deployed during the expedition in order to obtain estimates of the ice algal biomass.

Oral Presentation | S3 04

Development of KOPRI's operational high-resolution sea ice drift product

Jeong-Won Park

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ABSTRACT

Sea ice drift is a key driver of spatio-temporal variations in ice conditions. With the ongoing decrease of the Arctic sea ice extent and the increase of developing Arctic shipping routes, the need for more high-resolution near real time estimates of sea ice status is becoming crucial more than ever before. Sea ice drift has been retrieved mainly from low resolution spaceborne microwave radiometer and scatterometer, and the grid spacing is few tens of kilometers. Although the use of SAR has been distracted by the relatively low temporal resolution, the enormous amount of data from recent constellations like Sentinel-1 and RADARSAT Constellation Mission makes it feasible to develop an operational SAR-based sea ice drift monitoring service. The Copernicus Marine Environmental Monitoring Service (CMEMS) provides SAR-based sea ice drift products on a regular basis but the grid spacing is only 10 km which is not advantageous enough compared to the conventional ones. The goal of this study is to develop a processing scheme for an advanced sea ice drift product with finer scale and better spatio-temporal coverage. The use of dual-polarization and multi-scale estimations play key roles the proposed scheme. Compared to the CMEMS product, the number of drift vectors increased on average by 11%, and it was found that HV channel contributes as much as HH does, especially in early freezing phase after summer melt. The results show the feasibility of developing KOPRI's operational SAR-based high-resolution ice drift monitoring service which is supposed to start from 2023.

Oral Presentation | S3 05

Intensive oceanographic and geophysical observation campaign off Sabrina Coast, East Antarctica, in 2019/2020

Shigeru Aoki

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ABSTRACT

Aurora Basin in East Antarctica is characteristic of its bed topography similar to that of West Antarctica. Totten Glacier off Sabrina Coast is the outlet glacier of the basin, whose drainage system as a whole has a potential of 3.5m rise of global sea level. Recent various researches have revealed Totten Glacier and nearby ocean-ice system are changing, which has some similarity with the situation in West Antarctica. Totten Glacier is now losing its ice mass and has a potential of contributing to a significant sea level rise in the future. Warm water of the ocean off Sabrina Coast, flowing through a deep channel underneath the glacier, is considered as the major driver of the rapid ice melting, but yet little is known about the oceanic role in melting the ice. Although this region has been attracting growing attention, in-situ observational evidence is insufficient because of its inaccessibility. Based on Icebreaker Shirase, we conducted oceanographic and geophysical observations off Sabrina Coast, East Antarctica, during Dec. 2019 and Feb.-Mar. 2020 as a program of 61st Japanese Antarctic Research Expedition (JARE61). Bathymetric survey with multi-narrow beam were effective and describes new and detailed topographic features. We surveyed 5,300 km2 with 3,400 km long. The area near the ice sheet is characterized as relatively shallow shelf carved by glaciers, with a deep basin (800m) in the central shelf and relatively deep continental shelf edge (500m) offshore. Hydrographic measurements, including CTD/MS and XCTD, revealed the ubiquitous presence of deep warm water in this region. Air-borne XCTD and XBT helped enhance the spatial sampling in difficult access area, and largely expand the distribution of water mass property. Warm water was found near the bottom throughout the study area, with its temporal change from days to years time scales. The ubiquitous presence of warm deep water indicates the continuous intrusion of modified Circumpolar Deep Water approaching to the cavity of Totten Ice Shelf. At the same time, sediments and their cores were taken for the first time in this region and sea ice research including surface wave motion measurements were conducted at the marginal ice zone off Dolton Polynya. International cooperation was effective in filling gaps of observational systems. Further analysis of these data enables us to decipher a detailed pathway of warm water and meltwater discharge to and from the Totten Glacier Ice Shelf and its historical evolution.

Oral Presentation | S3 06

Opposing decadal trend of wintertime mixed layer depth in the Pacific and Indian sectors of the Southern Ocean from 2005 to 2019

Hajoon Song

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ABSTRACT

The Southern Ocean is characterized by a deep mixed layer that reaches a few hundred meters in winter and allows for the vertical exchange of properties such as heat and carbon dioxide. In this study, we used five Argo gridded data products to demonstrate that the wintertime mixed layer depth (MLD) near the Antarctic Circumpolar Current (ACC) in the Southern Ocean had a trend of shoaling in the Pacific sector, and deepening in the Indian sector from 2005 to 2019 while no trend is seen in the Atlantic sector. Even with inevitably large uncertainties in the MLD stemming from multiple layers of processing in the calculation, these trends are statistically significant, exhibiting changes of a few meters per year. These trends can be at least partially explained by atmospheric forcing, such as wind speed and surface atmospheric temperature (SAT); MLD deepening was correlated with higher wind speeds and lower SATs, and vice versa. The wintertime MLD trend was steeper in the last eight years than in the first seven years, and atmospheric conditions can explain the trend better in this period. These trends may have notable lasting impacts on physical and biogeochemical processes in the Southern Ocean.

Oral Presentation | S4 01

Aero-Structural Design and Analysis of Pylons for a 16-Element Airborne Radar Antenna Array

Mishal Thapa

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ABSTRACT

We designed and developed an ultra-wideband antenna array for airborne radar measurements over the frequency range of 170-500 MHz from a Twin Otter aircraft. Two 16-element arrays will be mounted under each wing for sounding ice, imaging an ice-bed interface over a very wide swath, and mapping internal layers with fine angular resolution from the surface to the bed. A high sensitivity radar with a loop gain of more than 250 dB is needed to map internal layers of disturbances near the bed and sound about 5-km thick ice. We increased the number of elements from 8 to 16 to obtain high gain particularly at about 450 MHz and also to obtain a large virtual aperture of about 30 elements (~ 10 m long aperture at 450 MHz). This will improve angular resolution and enable imaging of the ice bed over a very large swath. The large virtual aperture will be obtained using multiple-input and multiple-output (MIMO) techniques. The spacing of antenna elements, antenna elements, and pylon are designed to meet electrical, aerodynamic, and structural constraints. Each antenna element is designed to meet bandwidth requirements with a typical pylon that can be mounted to ribs in the Twin Otter wings. The pylon design is then optimized to meet both electrical and aerodynamic constraints. The structural analysis was carried out using finite-element analysis, whereas the aerodynamic analysis was performed using computational fluid dynamics with Reynolds Averaged Navier Stokes for turbulence modeling. In this research, the various designs considered for the pylons made of composite materials are presented along with simulation results. Based on the consideration of structural performance/responses (such as mass, material failure, buckling, and natural frequency) and the aerodynamic performance metrics (such as lift, drag, and moment), the optimal pylon design among various pylon designs is suggested. Our preliminary results indicate that we can meet both electrical requirements for the UWB radar and also aerodynamic and structural constraints for operation on a Twin Otter aircraft. In this talk, we will discuss the radar and antenna array design requirements, and present the results of our complete analysis of the 16-element antenna array.

Oral Presentation | S4 02

The Architecture of Fault-Tolerant Networks for Remote Data Acquisition in Polar Regions

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ABSTRACT

Biologging is a way to study wild animals, which generally using miniaturized animal-mounted instruments to log and relay data of animal's behavior, environment, and movement. In polar regions called the Arctic and the Antarctic, many researchers attach bio-loggers to each animal, wait a certain time, retrieve bio-loggers that are already installed on the animals in person. To overcome this inefficiency, we propose the architecture of Fault-Tolerant Networks (FTN), including network devices, interfaces, protocol stacks, operation scenarios. The main purpose of our proposed FTN is to continuously collect the observation data of bio-loggers and to provide stable connectivity in unpredictable and harsh environments. FTN defines two types of transmission devices: A Full Function Device (FFD) and a Reduced Function Device (RFD), which is adopted from IEEE 802.15.4. FFD should be a relay node connecting between a backbone network and the place where bio-loggers collect data from animals. FFD could be Unmanned Aerial vehicles (UAV) such as drones or floating hot air balloons, and we call these Flying Base Station (FBS). RFD is a device that is directly attached to an animal and stores data. This is divided into three sub-classes according to its capacity: Bio tags, Bio-loggers, and Photo- or Video-loggers. Additionally, we suggest a protocol stack for FTN, which has physical, data-link, network, transport, and application layers as well as a bundle layer for a stable and reliable connection. We can adapt the existing protocols, for example, Wi-Fi or LoRa for physical and data-link layers, Internet Protocol (IP) for a network layer, Transmission Control Protocol (TCP) or User Datagram Protocol (UDP) for a transport layer, File Transfer Protocol (FTP) for an application layer. Especially, in hostile environments like polar regions, Bundle Protocol (BP) in a bundle layer plays an important role to ensure connectivity. It provides a special service 'Storeand-Forward' to save data in persistence storage and retransmit the data once the connection is stable.

Oral Presentation | S4 03

Estimation of high-resolution sea ice motion in the Arctic Ocean using Sentinel-1 image

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ABSTRACT

In order to better understand the rapidly changing marine environment and sea ice characteristics of the Arctic Ocean due to the continuous decreasing of sea ice, this study was carry out estimating the sea ice motion of the Arctic ocean in more detail using satellite data. The satellite data for the high-resolution sea ice motion used Sentinel-1 EW GRD SAR images with a spatial resolution of 40 m during 2015 to 2020 collected by the European Space Agency (ESA). For distinguishing the open sea and sea ice from satellite images, regression analysis and inflection detection were applied to the backscattering value of satellite images. The sea ice motion was calculated only in the area where sea ice was present by masking the area where the water was exposed. The sea ice motion retrieved from SAR images was obtained by Maximum Cross-Correlation (MCC) and Robust Optical Flow (ROF) methods using feature tracking of the paired images. Since the accuracy and the time required for calculating the sea ice motion are influenced by the size of the window set in the image, the most efficient window size was determined by the various window sizes. The high-resolution sea ice motion based on the SAR image was verified with the drift buoy data provided by the International Arctic Buoy Program (IABP) and the Ice-Tethered Profiler (ITP) and the medium-resolution sea ice motion data from the National Sea Ice Data Center (NSIDC). The difference of speed between drift buoys and high-resolution sea ice motion by MCC and ROF method are 0.0318 cm/s and 0.0971 cm/s averagely. When compared with the NSIDC's sea ice motion, difference of both methods are 0.8235 cm/s and 0.9505 cm/s, respectively. In addition, some NSIDC sea ice motion showed different moving pattern compared to drift buoys. It is believed to cause the low-spatial resolution. The high-resolution sea ice motion was more similar moving pattern of the drift buoy than that of the NSIDC.

Oral Presentation | S4 04

Passive microwave satellite L-band sensor-based polar sea ice surface roughness retrieval and its variation analysis

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ABSTRACT

The interaction between the Arctic sea ice and climate change affects Earth's surface energy budget, commercial human activities, and ecosystem. During the past decades, various satellite remote sensing techniques using synthetic aperture radar (SAR), radar and laser altimeters, passive microwave radiometers have been playing a crucial role in monitoring and analyzing the Arctic sea ice information including sea ice extent (SIE), concentration (SIC), and thickness (SIT). In particular, sea ice roughness (SIR) is one of important variables to affect sea ice surface reflection as well as a fundamental physical parameter for estimating SIC and SIT. However, the retrieval of SIR using satellite observation has been a difficult problem. This study presents a Lband radiometer-based small-scale SIR retrieval method (Hong, 2010a, b) and thin SIT (<0.5m) estimation using a conversion relationship between thin SIT and small-scale SIR (Jo et al. 2019). For this purpose, we used the Soil Moisture Active Passive (SMAP)-retrieved SIR and Soil Moisture and Ocean Salinity (SMOS) thin SIT data during December from 2015 to 2018. Our results showed high accuracy (bias = 0.03 cm, RMSE = 0.228 cm, and CC = 0.496) between the SMOS-estimated SIR and SMAP-retrieved SIR during December from 2015 to 2018. We applied the Empirical orthogonal function (EOF) analysis on the retrieved-SIR. The first spatial EOF mode showed the anomalies in Beaufort Sea had a negative correlation with those near coastlines of Russia. The second EOF mode may indicate a negative correlation between the inner Arctic region and its boundaries. The principal components of SIR anomalies might be related to SST, wind speed, El Niño–Southern Oscillation (ENSO), Pacific-North American (PNA), and Atlantic multidecadal oscillation (AMO), respectively. The details of method and results will be presented in the oncoming symposium.ReferencesJo, S., Kim, H.-C., Kwon, Y.-J., and Hong, S., 2019, Circumpolar Thin Arctic Sea Ice Thickness and Small-Scale Roughness Retrieval Using Soil Moisture and Ocean Salinity and Soil Moisture Active Passive Observations, Remote Sensing, 11(23), 2835. Hong, S. 2010a, Surface roughness and polarization ratio in microwave remote sensing, International Journal of Remote Sensing, 31(10), 2709–2716.Hong, S. 2010b, Detection of small-scale roughness and refractive index of sea ice in passive satellite microwave remote sensing, Remote Sensing of Environment, 114(5), 1136–1140.

Oral Presentation | S5 01

Solute sources and weathering processes in subglacial lake systems beneath the West Antarctic Ice Sheet

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ABSTRACT

Lakes that are hydrologically dynamic on sub-decadal time scales are a feature of subglacial hydrologic systems underlying the ice streams of the Ross Sea sector, West Antarctica. Two of these dynamic lakes, Mercer Subglacial Lake (SLM) and Whillans Subglacial Lake (SLW), located beneath the adjacent Mercer and Whillans ice streams, have been accessed for the first time in recent years, using clean drilling techniques. The catchment basins for these two subglacial lakes span contrasting source regions: water flowing into SLW is sourced only from West Antarctica, whereas SLM has potential sources from both West and East Antarctica. Water and sediment from SLW were sampled during the austral summer of 2012-13. The lake contained freshwater (< 1000 mg/L total dissolved solids) with mineral weathering as a significant solute source, augmented by a minor contribution from relict sea water. SLM was sampled during the austral summer of 2018-19 and was also freshwater. Here, we present aqueous geochemistry from SLM and characterize the likely solute sources for these waters. These data will be compared with those generated from SLW for an improved understanding of weathering processes beneath these ice streams, and better definition of the potential impact that solute and suspended sediment exported from beneath the ice streams may have on the fertilization of coastal ocean systems.

Oral Presentation | S5 02

Holocene marine incursion supports a subglacial microbial community in the active hydrologic system beneath the West Antarctic Ice Sheet

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ABSTRACT

Microbial life beneath the West Antarctic Ice Sheet (WAIS) may thrive wherever the active hydrological system interacts with sediments containing carbon from recent marine incursion. The Subglacial Antarctic Lakes Scientific Access (SALSA) team cleanly accessed and sampled Mercer Subglacial Lake (SLM) during the 2018-2019 Antarctic field season. Following penetration of the 1087 m overlying ice sheet at Mercer Ice Stream, Siple Coast, the team collected 70 L of water from the borehole and the lake, ~4 m of parallel multicores from the top 49 cm of sediment, and 2.1 m (composite) of gravity cores penetrating the deeper sediment. Throughout all units, 13C and 14C composition of organic matter indicates marine incursion in the mid-Holocene, whereas marine diatom microfossils indicative of the Holocene or Pleistocene are absent. Constraint of dissolved organic carbon, particulate organic carbon and dissolved inorganic carbon in the sediment porewaters and lake water column indicate exchange of young 14C-bearing sedimentary organic carbon into the water column through bacterial remineralization. When constrained to the volume of the lake through one fill-drain cycle, the flux of dissolved organic carbon from the sediment into the water column calculated from natural-level radiocarbon measurements is higher than that directly measured in laboratorydetermined uptake rates (using radiolabeled substrate). However, consideration of the volume and age of water entering SLM from upstream draws these independent estimates of heterotrophy closer. The history of biogeochemical exchanges of young marine carbon recorded by short-lived SLM has elucidated not only a chemical source of metabolic energy sustaining the subglacial microbial community, but also the recent history of marine incursion supplying these biosynthetic precursors. The difference in rates of microbial heterotrophy informs us that the entire subglacial hydrological system can sustain translocation of carbon from marine organic matter into the microbial community, at least where subglacial waters interact with sediments recently permeated by relict marine carbon.

Oral Presentation | S5 03

Metabolic potential in Subglacial Lake Mercer inferred from singlecell genomic data

Kyungmo Kim

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ABSTRACT

The extreme subglacial environments in Antarctica are characterized by no light, cold temperature, high pressure, nutrient deficiency, and prolonged isolation from the outside world. The previous access into subglacial lake Whillans shed light on what kind of microbial life can exist beneath the ice sheet, whereas microbially-mediated biogeochemical cycles at the molecular level remain unknown. We here for the first time obtained the genomes of 1,377 singe cells (SAGs) isolated from the water column and sediments of subglacial lake Mercer (SLM), West Antarctica. The phylogenomic analysis using the SAGs showed that there is a taxonomic distinction between the water column and sediments, and that microbes confined to subglacial environments have evolved at a slower pace. The mapping of the SAG genes into metabolic pathways revealed that biogeochemical cycles for carbon, nitrogen, sulfur, iron, and methane operate fully or partially in SLM. Carbon metabolisms support both chemosynthetic and chemoheterotrophic lifestyles with adaptation to the oxic-suboxic gradient. The SAGs additionally exhibit metabolic potentials for N mineralization, dissimilatory nitrate reduction to ammonia, oxidation of reduced sulfurs, ferrous oxidation, C-P lyase-based methane production, and hydrogen oxidation. Consistent with the SLM environment that the DOC lacks by no allochthonous input and depletion of marine organic relict in sediment, this study shows that microbes largely rely on inorganic electron donors. Specially, reduced sulfurs including sulfide and thiosulfate that may be supplied from lithogenic sources or biological mineralization seem to be major energy source. Nutrients produced in SLM may influence the biogeochemical cycling in the Southern Ocean.

Oral Presentation | S5 04

What can we learn from clay mineralogy of SLM sediment?

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ABSTRACT

Structural and chemical modification of clays during mineral diagenesis accompanying with biotic/abiotic redox reaction is closely linked to environmental change. In particular, illite crystallinity and elemental composition of smectite are useful to understand the redox conditions in sediment and distinguish the sediment source of multi-provenances. Crystallinity, crystal size distribution, Al/Si ratio and Fe-oxidation state of illite in Subglacial Lake Mercer (SLM) sediments reflected the unique mineral redox reactions typical in oligotrophic subglacial system. In addition, Fe-bearing clay minerals may release the bioavailable Fe when the structural Fe is reduced, corresponding to biotic/abiotic redox reactions, that can fuel the microbially mediated mineral alteration.

Oral Presentation | S5 05

Subglacial lake floods correlated with the ice tongue disintegration in the Thwaites Glacier, Antarctica

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ABSTRACT

There had been two consecutive rapid drainage or refilling events of several subglacial lakes (SGLs) under the Thwaites Glacier (TG), Antarctica in 2013 and 2017. Our systematic detection of active SGLs using Cryosat-2 satellite altimetry reveals that there are at least a few tens of lakes beneath the TG. The consistent drainages occurred in most SGLs in 2013 recorded a total loss of about 10 km3, the largest over all of Antarctica as a single glacier's drainage event. The total refilling rate of all SGLs between the two drainage events is comparable to the basal meltwater production in glacier catchment suggested in previous modelling researches. A grouping of lakes shows roughly sequential drainage onsets from upstream to downstream in some groups, but the relationships among the groups are not downward-sequential. The times necessary to refill the lake groups are expected as 3 – 6 years, indicating that most of SGLs would be almost fully filled just prior to the drainage event in 2013 if there was no significant drainage event in the 2000s. The fact that the most preceding event started in a downstream lake group suggests that activities in downstream lakes could control upstream lakes from far distances in a critical condition in which all lakes are fully filled. The acceleration of ice speed around the grounding line caused by the disintegration of Thwaites Ice Tongue are closely related with the onset of SGLs' activity. These relationship among the ice tongue disintegration, ice flow acceleration, and flood of SGL suggest that the ice flow acceleration caused by ice tongue collapse could ventilate a large amount of subglacial water.

Oral Presentation | S6 01

MICROSTRUCTURE OF LAMINATION IN CORE RS15-LC42 IN THE CENTRAL BASIN OF THE NORTHWESTERN ROSS SEA: PRELIMINARY RESULTS

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ABSTRACT

An 11.75 m-long core RS15-LC42 was collected at the water depth of 2084 m in the Central Basin (71º49.40'S, 178º34.76'E) of the northwestern Ross Sea. About 1 Ma of magnetobiostratigraphic age was estimated by Ohneiser et al. (2019), and this core deserves providing the long-term record of depositional process between the glacial and interglacial periods, which differs from the continental shelf setting in the Ross Sea. Core LC42 consists of three major sediment facies: IRD-poor bioturbated mud, IRD-rich massive mud, and laminated mud (LM). These facies are intercalated throughout the core and, particularly, 8 LM facies were distinct, despite the different thickness from about ten cm to more than 2 m. In this study, we focus on the uppermost LM 1. LM 1 occurs between 150 cm and 175 cm downcore with the upper and lower boundaries to IRD-poor bioturbated mud. The lower boundary seems clear whereas the upper boundary is fairly bioturbated. A series of a few mm to a few cm-thick light and dark laminae were interlayered to form LM 1. At 165-167 cm downcore, thin section was made for the microscopic observation and polished section was prepared for SEM examination. Based on microscopic and SEM observation, the detailed description of microstructure will be discussed at the presentation.

Oral Presentation | S6 02

Reconstruction of cryospheric and paleoceanographic changes of the past 1 Myrs from the record at the continental margin, NW Ross Sea

Min Kyung Lee

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ABSTRACT

During the most recent glacial cycles of the Pleistocene, grounded ice advanced and retreated over a distance of 1000 km from the Ross Sea inner shelf to the continental shelf edge and back. As a result, the continental shelf sediments in the Ross Sea are grounded and compacted, making it difficult to collect a continuous record except for the sediment deposited after LGM, and therefore, it is difficult to reconstruct paleoenvironment of a longer record through marine sediment study. On the other hand, in the continental rise outside the continental shelf, the sedimentation rate is relatively lower than that of the continental shelf, but the longer sediment record during the Pleistocene can be obtained. The Central Basin is located in the northwestern Ross Sea continental slope and rise.

The Central Basin is located in the northwestern Ross Sea continental slope and rise. A 11.75 m-long core RS15-LC42 was collected from the southwestern part of the Central Basin by the Korean RVIB Araon in 2015. This core has records of about 1.3 million years, and the chronology is established based on magnetic reversal stratigraphy, diatom biostratigraphy, and relative paleointensity records. Based on magnetic paleo-intensity records the sedimentation is almost continuous. LC42 core is composed of two distinct sedimentary facies: 1) well-laminated greenish gray diatom-rich silty mud, and 2) massive/bioturbated light gray sandy mud. Facies 1 includes high content of TOC and opal, while facies 2 shows high magnetic susceptibility value and bear IRDs (clasts > 2 mm). The diatom assemblage includes early-Pliocene and Miocene taxa, which indicates reworking in LC42 sediment. Reworking in faces 1 sediment is more severe compared to facies 2 sediments. Clay mineral and Nd isotope composition from <63μm bulk sediment suggests that the two facies sediment originated from different sources. Be isotope change in the sediments indicate that when facies 2 was deposited rather than facies 1, the sediments were exposed to atmospheric influences, and that the sea surface in the study area was relatively less covered with sea ice. In addition, the fact that IRD can be transported to the study area means that calving occurred actively on the ice sheet and that the shelf area was not intensively filled with sea ice. Based on these data, Facies 1 is considered to be remobilized and deposited by bottin currents from the sediments carried through the Joides trough by ice sheet grounding. In the case of the Facies 2, the contribution of the origin of the facies 1 was reduced as the IRD carried by Iceberg was added. The weakened degree of diatom reworking with the occurence of IRD supports the partial in situ origin of the facies 2 sediments.

Facies 1 and Facies 2 do not correlate with all glacial and inter-glacial periods, but they indicate that the advance of the ice sheet was severe enough to supply sediment to the continental rise, or they suggests that a period of time warm enough for the iceberg to reach the study area. This study reconstructed the relationship between climatic/oceanic change and cryospheric evolution through the latest Pleistocene in the Ross Sea.

Oral Presentation | S6 03

Pre-LGM sedimentological feature and paleo oceanographic changes in the Central Basin (Western Ross Sea)

Fiorenza Torricella

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ABSTRACT

Sedimentary records on the Ross Sea continental shelf area enable a direct study of past behaviour of ice sheet/shelf, but they are often limited to the last glacial maximum (e.g. Smith et al., 2019). However, the sediment sequence on the continental margin could be a potential archive for older than LGM sedimentary sequence. For this reason, we propose the multidisciplinary study of three core collected at the Central Basin, in the western continental margin of the Ross Sea. This area is located at the mouth of the JOIDES Basin and it is a key area where the dense and cold High Salinity Shelf Water outflows (from) the shelf margin and contributes to forms the Antarctic Bottom Water. Here we present the grain size analyses, geochemical and chemical analyses together with the chronological framework obtained combining 14C radiocarbon dating paleomagnetic measurement, and diatom biostratigraphy. The age model indicates that the investigated sedimentary sequence reaches in a core location the last geomagnetic reversal (Matuyama–Brunhes transition). The main goals of this study are to identify the sedimentary facies and the paleoenvironmental changes recorded by the sediments in the investigated basin. This study is part of the STREAM Project (Late Quaternary evolution of the ocean-ice sheet interactions: the record from the Ross Sea continental margin Antarctica), financed by the Italian Ministry of Foreign Affairs and International Cooperation between Italy and Rep. of Korea (2019–2021 years).

Oral Presentation | S6 04

Past and recent sedimentary dynamics recorded in sedimentary cores collected east of the Iselin Bank (Ross Sea, Antarctica)

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ABSTRACT

We propose the main results of a multidisciplinary study performed on four cores collected along a transect from the shelf break up to the rise to the East of Hillary Canyon, a huge feature across the continental slope connected to the Glomar Challenger Trough. The Hillary Canyon and its channel-levee system, active from the late Miocene, are the dominant features. This is a key area in which the dense Ice Shelf Waters overflow through the Hillary Canyon and mixes with the Antarctic Slope Current contributing to the AABW. The comparison of several parameters permits us to highlight a cyclical trend that in the more distal and deepest core covers the isotopic stages between MIS1 and MIS 7. The study is developed in the framework of the STREAM project, funded by the Italian Ministry of Foreign Affairs and International Cooperation and the National Research Foundation of Korea.

Oral Presentation | S6 05

Multidisciplinary analysis of three box cores collected east to the Hillary Canyon (Eastern Ross Sea, Antarctica)

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ABSTRACT

The LGM and post-LGM history of the Antarctic Ice Sheet (AIS) can be reconstructed by studying cores and box cores collected along the continental slope of Antarctica. According to several authors (Shipp et al., 1999; Mosola & anderson, 2006; Halberstadt et al., 2016; anderson et al., 2018; Gales et al., 2021) the Western Antarctic Ice Sheet (WAIS) was grounded near the shelf break in many sectors of the Eastern Ross Sea (ERS) during the Last Glacial Maximum (LGM). However, the post-LGM retreat is characterized by lacks and uncertainties. Three box cores were collected east of the Hillary Canyon, which carves the ERS continental slope south-east to the Iselin Bank, during the XXIX PNRA (Italian National Antarctic Research Program) expedition (2013-2014). The samples were studied in the frame of the ROSSLOPE II (2013/AN2.01) PNRA project and then in the frame of the STREAM Project (Late Quaternary evolution of the oceanice sheet interactions: the record from the Ross Sea continental margin, Antarctica (project funded by the Italian Ministry of Foreign Affairs and International Cooperation and the National Research Foundation of Korea). Grain size, organic matter, biogenic silica and water content, magnetic susceptibility and chemical composition (XRF core scanner) were analyzed in order to reconstruct the paleoclimate of Late Quaternary. organic matter (14C AIO dates) was used to date each box core. The results of these analyses are presented here. References anderson J.B., Simkins L.M., Bart P.J., De Santis L., Halberstadt A.R.W., Olivo E. & Greenwood S.L. 2018., Seismic and geomorphic records of Antarctic Ice Sheet evolution in the Ross Sea and controlling factors in its behaviour.

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Oral Presentation | S6 06

Depositional processes in the Drygalski Basin of the Ross Sea since the Last Glacial Maximum

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ABSTRACT

Gravity cores were obtained at 4 sites (DG12-01, 02, 04, and 05) in the Dryglaski Basin north of Drygalski Ice Tongue in the Ross Sea, Antarctic. DG12-GC01 (241 cm) consists of gravelly mud diamicton (~60 cm) at lower part and bioturbated mud (~180 cm) at middle-to-upper part. Lithologic facies of DG12-GC02 (87 cm) are mostly mud and sandy mud interbedded with gravelly mud (~20 cm). DG12-GC04 (325 cm) has gravelly sandy mud at top and bottom parts with about 230 cm thick massive mud at middle part. Lithology of DG12-GC05 (332 cm) is divided into thick gravelly mud diamicton (~285 cm) at middle-to-lower part and bioturbated mud at upper part. The thin diamicton of DG12-GC01 and absence of diamicton of DG12-GC02 and DG12-GC04 are due to the thick Holocene sediments and less penetration to the diamicton. Based on the AMS 14C age dating, bioturbated mud facies of DG12-GC01 were deposited during the deglacial to Holocene after the Last Glacial Maximum (LGM). Generally, magnetic susceptibility, coarse-grained sediment fraction, and C/N ratio of all cores are higher at the lower part. It indicates that the sediments at the lower part were supplied from the grounding line or calving line of retreating ice sheet and ice shelf in the Ross Sea. On the other hand, water content, total organic carbon, total nitrogen, and biogenic opal contents are higher at the middle-to-upper part. It indicates that the surface water condition in the Drygalski Basin changed to seasonally open marine condition during the Holocene. The thick massive mud facies of DG12-GC04 are characterized by constant sedimentological and geochemical properties, which may indicate the depositional condition beneath the ice shelf where finegrained sediments were supplied consistently from the grounding line. The sediments of gravity cores in the Drygalski Basin preserved the Holocene depositional process since the LGM, recognized by diamicton near the grounding line, gravelly mud under the calving line, thick massive mud beneath the ice shelf, and bioturbated biogenic mud in the open marine condition.

Oral Presentation | S6 07

Late Pleistocene glacial-interglacial paleoceanographic changes in the Ross Sea

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ABSTRACT

The outer Ross Sea continental shelf and slope have experienced large variations in ice sheet extent over the Pleistocene. Ice sheet extent variations are largely driven by changes in the westward-flowing Antarctic Slope Current (ASC) at the continental shelf break. Incursions of warm modified Circumpolar Water on to the shelf are regulated by this current, and it is thought to have triggered past marine-based ice sheet retreat. Additionally, expansions of grounded ice sheets on the continental shelf have fundamentally altered the Ross Sea water mass formation processes, influencing surface water properties including salinity, sea ice cover, nutrient utilization, deep-water ventilation, and primary productivity. The geochemical, physical properties, grain size, bulk d15N, and diatom records were reported for the late Pleistocene from sediment cores from the Iselin Bank on the outermost continental shelf in the Ross Sea. These core sites were not overridden by grounded ice sheets during the late Pleistocene glacialinterglacial cycles, allowing for a continuous archive of glacimarine environments that were influenced by the ASC. They showed clear glacial-interglacial variations during the late Pleistocene.

Oral Presentation | S6 08

Bottom-current-controlled sedimentary and geomorphic processes in the northwestern Ross Sea margin, Antarctica

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ABSTRACT

Decadal measurements of ice mass balance changes and theoretical simulations suggest that ocean warming may be responsible for floating and grounding ice thinning. However, the mechanism driving heat and salinity exchange across high latitude continental margin between ice and ocean is not yet fully understood. An integrated analysis of geophysical, geological, and oceanographic model simulations in polar margins may provide insights into the interaction between ice-sheet evolution and bottom-water current activity. Recent seismic and sediment core studies in the northwestern Ross Sea, Antarctica, reveal well-developed bottom-currentcontrolled deposits in the Central Basin and the fluctuations of the Antarctic Slope Current during the Pleistocene glacial and interglacial periods. Therefore, the Central Basin is ideal for investigating both the paleo and present-day depositional and oceanographic settings from the analysis of spatiotemporal development of sedimentary and geomorphic features. Here we present acoustic seabed mapping results in the Central Basin using the multichannel seismic (MCS), subbottom profiler (SBP), and multibeam echo sounder (MBES) data combined with the sediment core analysis and general ocean circulation model. Contourite drifts lying over and along the flanks of bathymetric highs are recognized according to mound-shaped sedimentary deposits, with stratified acoustic facies made of reflectors pinching toward moat. Relatively high MBES backscatter intensity values, corresponding to thin (or absent) transparent facies in the SBP data, characterize the crest and undulated eastern flank of the Hallett Ridge, the western boundary of the Central Basin. This facies is resulting from bottom currents sea bed winnowing, during glacial periods as supported by sedimentological analysis. In contrast, levees of the submarine slope channels in the southwestern Central Basin floor are characterized by thick, stratified facies in SBP data with relatively low MBES backscatter intensity values, indicating over bank deposits, resulting from down-slope gravity flows from the JOIDES Trough. These observations are consistent with the ocean circulation model that shows a relatively higher speed bottom current along the eastern flank of Hallett Ridge, where a westward flowing alongslope bottom current is mixed with the down-slope shelf water flow.

Oral Presentation | S6 09

Tephrochronology in the Western Ross Sea and its role in paleoenvironmental analyses

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ABSTRACT

Marine sediment sequences may contain deposits produced by large explosive volcanic eruptions i.e., tephra and cryptotephra (non-visible tephra). These materials can be dispersed over regional to continental-scale areas in relatively short times and can be used as chronostratigraphic markers. Such tephra deposits may represent a potentially invaluable chronostratigraphical tool that is essential to date sedimentary archives, enable correlation over significant distances, and link and synchronize different paleoclimatic and palaeoenvironmental archives. The Northern Victoria Land has been the site of intense and recurrent volcanic activity since 500 ka which resulted in the deposition of several discrete tephra layers in sediment sequences of the Western Ross Sea. Several volcanoes are still active and have eruptions in the Holocene. In the last decade we have carried out tephrochronological researches on tephra and cryptotephra from the marine sediments of the Sea Ross. Thanks to detailed fingerprinting of the tephra layers, we were able to correlate distal deposits with the volcanic sources and in particular with Holocene eruptions of Mount Melbourne, Mount Rittmann and The Pleiades. Besides the significant improvement of the volcanological knowledge, we furnished new independent markers for the dating, correlation and synchronization of marine archives with the terrestrial records (on-land and ice records), which are fundamental for understanding the nature of connections and coupling processes between atmospheric, ice-sheets, ocean dynamics, marine sedimentary systems and climate change.

Oral Presentation | S6 10

Changes in the minero-petrographic composition of late Quaternary sediments in the slope-basin area of Western Ross Sea (Antarctica)

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ABSTRACT

Ross Sea (Antarctica) is a key region to understand the behavior, influenced by cycles of advances and retreats, that Ross Sea Ice Shelf held in the past. The sediments recorded cold conditions until the Last Glacial Maximum (LGM), and then deglacial conditions. Whereas the minero-petrographic composition of Ross Sea continental shelf sediments is well documented, the slope-basin area is poorly studied. The STREAM Project - Late Quaternary evolution of the ocean-ice sheet interactions: the record from the Ross Sea continental margin (Antarctica) – investigates gravity cores in the Central Basin, a semi-closed basin located in Western Ross Sea. Here we present a detailed minero-petrographic characterization of Pleistocene to Holocene sediments from three gravity cores: ANTA95-98c, KI13-C1, KI13-C2. Sediment samples were sieved and separated between gravel and sand. Gravel was analyzed in thin section and classified into eight groups based on the clast's lithology (intrusive, quartz fragment, basaltic volcanic, felsic porphyry, dolerite, metamorphic, sedimentary, and not defined). Sand was analyzed in thin section applying point-counting method and the mineralogical composition was recorded. The results evidence compositional differences between each core; some compositional changes occur within the depositional record of each core. Compositional data can also provide information about the provenance and source region of these sediments, and their changes during glacial-deglacial cycles that characterized the Quaternary.

Poster Presentation | P1 01

Ocean acidification impacts on the pteropod shell density in the Arctic and Subarctic oceans

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ABSTRACT

This study was based on samples collected on board the icebreaker ARAON in July and August 2017, during an Arctic research cruise organized by the Korea Polar Research Institute. Bongo net was used to collect pteropod samples in both the Arctic and Subarctic oceans. Biological variables (e.g., pteropod shell density, thickness, and width) were measured using a microcomputed tomography scanner in JAMSTEC in Japan. The total alkalinity and pH of seawater were also measured and used to estimate its aragonite saturation state. A positive correlation was found between the aragonite saturation state and pteropod shell density in the upper layer (depth < 50 m; r = 0.69, p-value < 0.0001). Notably, pteropods recovered from the Arctic Ocean were bigger than those from the Subarctic Ocean; however, the former had lower shell density than the latter. Overall, our results show that ocean acidification is closely related to the health of pteropods in the Arctic and Subarctic oceans. We hence highlight the importance of monitoring the spatial-temporal relationships between ocean acidification and the properties of pteropod shells to better understand the impact of climate change on Arctic ecosystems.

Poster Presentation | P1 02

The Issue of climate change evolution within the Antarctic Treaty System

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ABSTRACT

The climate change issues in Antarctica are the subject of discussions in every year meetings within the Antarctic Treaty System (ATS) bodies: Antarctic Treaty Consultative Meetings (ATCM), Committee on Environmental Protection (CEP) and Scientific Committee of the Commission for the Conservation of Antarctic Marine Living Resources (CCAMLR). National delegations and invited observers distribute at ATCM/CEP working and information materials regarding the role and place of Antarctica in global climate change as well as the implications of global climatic changes on Antarctica, while the CCAMLR Scientific Committee analyze the impact of climate change on the aquatic habitats of Antarctic marine living resources and the changes in their qualitative and quantitative biodiversity. The environmental issues, particularly climate change, were not always a central focus for Antarctic Treaty Parties. In the first ATS period (1959 – 1980, between the signing the Antarctic Treaty and CCAMLR) the main purpose of international cooperation was to preserve peace between parties and turn international conflicts into stability and effective co-operation. In 1980 – 1990 predominant themes were the prospect of exploration and exploitation of natural researches in the Antarctic region, as well as the growing concern about the conservation of Antarctica. Since 1991 (with the signing of the Environmental Protocol) Antarctica as a potential region of mining was turned into natural reserve devoted to piece and science. At the ATCM XXX (2007) national delegations recognized the importance of interactions between Antarctica and the global climate changes, and for the first time revised ATCM agenda item to read as science issues, including climate-related research. In the same time CEP X (2007) added climate change as a sub-item under its agenda item on environmental monitoring and reporting. The ATCM Multi-Year Strategic Work Plan 2019-2022 includes, inter alia, share and discuss strategic science priorities in order to identify and pursue opportunities for collaboration as well as capacity building in science, particularly in relation to climate change, its current and future effects on Antarctic and Southern Ocean biodiversity. Another relevance to the ATS, also highlighted as a priority in the Multi-Year Strategic Work Plan, is modernisation of Antarctic stations in context of climate change. In turn, CEP Five-year Work Plan 2019 contains as a high priority the issue on climate change implications for the for management of Antarctic environment. Its address the recommendations of the 2010 Antarctic Treaty Meeting of Experts on Implications of Climate Change for Antarctic Management and Governance, in particular, implementation and review of the Climate Changes Response Work Programme (CCRWP). The CCRWP provides a mechanism for identifying and revising goals and specific actions by the CEP to support efforts within the ATS to prepare for, and build resilience to, the environmental impacts of a changing climate. Since extensive knowledge on the consequences of climate changes to the Antarctic environment is a prerequisite for the governance and management of Antarctica, it requires further strengthen co-operation in long-term scientific monitoring and sustained observations of the Antarctic environment. In this regard, Ukrainian Vernadsky station as a fully-equipped geophysical observatory with the longest continuous series of meteorological data in Antarctica since 1947 and one of the ten most important reference ozone stations in Antarctica, contributes significantly to a co-ordinated Antarctic observing system and therefore the importance of its baseline data would only increase.

Poster Presentation | P1 03

Temperature waves: temporal variability of threshold temperatures in the Arctic

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ABSTRACT

Nowadays the climate is changing globally; climate change in the Arctic carries wide-ranging implications for indigenous and non-indigenous inhabitants, causing direct and indirect health effects. Climate change is manifesting itself in increase of ambient temperature, which may decrease the incidence of hypothermia and associated morbidity and mortality among Arctic residents. The thermal load of the environment on the human body is an important indicator of climate discomfort, especially the extraordinary conditions of the Arctic's extreme cold temperatures, combined with the strong wind. On the other hand, higher ambient temperatures at summer time may increase the effect of hyperthermia, with children, pregnant women and elderly people, as well as people with cardiovascular and respiratory disease, being the most vulnerable parts of the population. Extreme weather events, including both heat waves and cold spells, can seriously change subsistence hunting and fishing of indigenous population. The paper aims to identify and describe spatial and temporal changes in temperature thresholds for definition of extreme thermal events in the Arctic. Cold spells and heat waves are calculated using quantitative metrics such as the periods with extreme temperatures below 3% and higher 97% percentile of the seasonal distribution of mean air temperature, respectively. Trend analysis of these threshold temperatures, will highlight the ongoing climate changes.

Poster Presentation | P1 04

The impact of first-year sea ice on sulfurous particle formation in the Antarctic Peninsula

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ABSTRACT

Dimethyl sulfide (DMS) is a major source for atmospheric sulfur-containing particles in the marine boundary layer. It has been postulated that future climate could be modulated by the degree of oceanic DMS emissions through a DMS-cloud condensation nuclei-albedo feedback. However, climatic role of DMS is still remain uncertain due to the lack of understanding in regional DMS-derived aerosolization process. In this regard, the field observations of atmospheric DMS, its oxidation products (methane sulfonic acid, MSA; non sea salt sulfate, nssSO42-), and aerosol size distributions were conducted at the King Sejong station (62.2oS, 58.8oW) in the Antarctic peninsula during the phytoplankton bloom period in 2018–2020. The air masses arriving at the King Sejong station were categorized into three origins including Antarctic Open Ocean (AOO; pelagic ocean), Western Antarctic Peninsula (WAP; first-year ice zone), and Eastern Antarctic Peninsula (EAP; multiyear ice zone) based on the air mass origins. The atmospheric DMS levels from AOO and WAP were two times higher than that of EAP. It is possibly linked with the abundance of efficient DMS producers in pelagic ocean (phaeocystis) and first-year sea ice (sea ice algae). However, the conversion efficiency of DMS-to-its oxidation products (MSA and nss-SO42-) from WAP and EAP were > two times higher than that of AOO, suggesting notable differences in atmospheric oxidation processes near the Antarctic Peninsula. Bromine monoxide (BrO) is known as the most efficient DMS oxidant in remote Antarctica, and mostly released from heterogeneous chemical processes occurred in first-year sea ice. The surface BrO mixing ratios from WAP and EAP were more than twice as high as that of AOO, respectively, consistent with the higher occupancy rate of first-year sea ice. Resultantly, the number concentration of newly formed particles was the highest from WAP, followed by AOO and EAP. These results indicate that formation and oxidation of DMS is highly origin-dependent near the Antarctic Peninsula, and first-year sea ice leads to increase in the formation of sulfurcontaining particles by acting as a source of DMS and BrO.

Poster Presentation | P1 05

Assessment of Tethered Balloon-Borne Observations of Arctic Low Cloud Properties

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ABSTRACT

Low-altitude clouds exert a major influence on the radiative energy budget in the Arctic region. Studies have shown that Arctic clouds contribute to warming of the surface through long-wave cloud radiative effect, except during the peak of summer when the cooling effect due to their high albedo dominates. Although low-altitude clouds remain one of the largest uncertainties in modelling the Arctic climate, our understanding of the thermodynamic processes governing these clouds remains incomplete. In-situ observations of cloud properties are scarce, and uncertainties involved in remote sensing observations make it difficult to precisely determine the cloud properties and the thermodynamic state of the atmosphere. To this end, we make a comparison between an in-situ observation of the low-altitude clouds using a cloud particle detector, and measurements taken from a ground-based remote sensing site (retrieved from CloudNet). We examine the measurements taken in Ny-Alesund, Svalbard, Norway, on October 1st 2019 with the Backscatter Cloud-probe with Polarization Detection (BCPD) mounted on a tethered balloon to obtain the cloud properties such as liquid water content (LWC), sizeresolved number concentration (NC) and polarization. The results from the observation are used to examine the assumptions made in estimating the properties of the mixed-phase clouds from the remote sensor measurements.

Poster Presentation | P1 07

Possible Link Between Barents-Kara Sea Ice and PM10 concentration in South Korea during January.

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ABSTRACT

In this study, we investigated the possible teleconnection between Barents-Kara Sea Ice and PM10 concentration in South Korea during the past 18 years (2001-2018) in January. From empirical orthogonal function (EOF) analysis for the PM10, we found that the first mode of EOF explained about 27.4% of the total variability and is a large-scale mode of the PM10 in South Korea. Interestingly, the large-scale mode is dominantly influenced by the horizontal ventilation effect than the vertical atmospheric stability effect. The pollution potential index (PPI), which is defined by the weighted average of the two ventilation effects, is highly correlated with the large-scale mode of PM10 at a correlation coefficient of 0.75, indicating that the PPI is a good measure for PM10 variability in South Korea. Regression maps show that the decrease of Sea Ice Concentration (SIC) over the Barents-Kara Sea (BKS) is significantly correlated with a weakening of high pressure over the Ural Mountain region, the anomalous high pressure at the upper-level atmosphere over the Korean peninsula, and the weakening of both the Siberian High and Aleutian low. These patterns are similar to the correlation pattern with the PPI, suggesting that the variability of SIC over the BKS may play an important role in modulating the variability of PM10 in South Korea through a teleconnection from the BKS to the Korean peninsula via the Eurasia continent. From the global climate model experiments, we confirm that those changes in SIC over the BKS can induce favorable atmospheric circulation patterns for increasing PM10 concentrations in South Korea.

Poster Presentation | P1 08

Enhanced carbon emission at moist tundra due to increased respiration under warming environment

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ABSTRACT

Permafrost, which occupies 25% of the Northern Hemisphere's terrestrial surface, contains 1460 GT to 1600 GT of carbon. 1035 GT is stored in the surface layer(0-3 m depth) of this area, which is 50% of the amount of carbon stored in the global surface layer (0-3 m depth). The carbon cycle is affected by various environmental factors. Permafrost region's temperature rise is more than twice that of the global temperature rise due to polar amplification. This rapid increase in polar region temperature causes melting of permafrost and releasing of carbon into the atmosphere, which increases the concentration of carbon dioxide in the atmosphere, accelerating global warming. However, since the climate change system predicted by the IPCC does not take into account the carbon emitted from permafrost, there is a problem that the concentration of carbon dioxide in the atmosphere in the future is underestimated. Therefore, it is necessary to analyze the changes in the carbon cycle due to an increase in temperature, and it is necessary to understand the positive feedback between warming-increase and carbon emission in this region under global warming. This study investigates sensitivity of variables of the carbon cycle, therefore, it analyzes change of carbon cycle when global warming is performed. In this study, Net Ecosystem Exchange (NEE) and Surface Air Temperature (SAT) are observed using a device observed covariance data from 2014 to 2019 in the Council region, Seward Peninsula, Alaska. The NEE at nighttime is regarded as Respiration (Re), and Gross Primary Production (GPP) is calculated using Lloyd & Taylor equation (1994). It is calculated temperature sensitivity using these data for each month. We find that temperature sensitivity of Re and GPP show positive correlation overall observed periods, and sensitivity of Re is greater than sensitivity of GPP (Re and GPP are similar in Aug). The temperature sensitivity of NEE is also analyzed as a positive correlation (weak correlation in August). The result demonstrated that carbon emission increases during senescence season, moreover carbon uptake decreases during growing season, as warming proceeds. This indicates that global warming could be accelerated further by increasing the concentration of carbon dioxide in the atmosphere at a much faster rate than we had predicted.

Poster Presentation | P1 09

Variability of sea surface salinity in the Nordic Sea

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ABSTRACT

The Atlantic Meridional Overturning Circulation (AMOC) is part of a global scale current system called the global conveyor belt driven by the thermohaline circulation. The circulation regulates climate by transporting heat and energy from the equator to the poles. AMOC originates at the high-latitude sea surface near the Pole. The North Atlantic Current, which brings warm and salty water up to the Nordic Sea, loses heat to the atmosphere and becomes denser. This denser water sinks into the basins of the Nordic Sea and enters the Arctic Ocean or crosses the Greenland-Scotland Ridge towards the equator. Due to recent accelerated global warming, the Greenland ice sheet and Arctic sea ice are melting at a rapid rate, which changes the highlatitude marine environment and affects the AOMC. In this study, ocean reanalysis field data and satellite data from 2001 to 2019 were used to estimate the impact of climate change and polar warming on the sea surface salinity (SSS) in the Nordic Sea. First of all, the spatiotemporal characteristics of SSS variability were analyze. The SSS in the Nordic Sea showed distinct annual variability. The first leading Empirical Orthogonal Function (EOF) revealed the influence of the inflow of the East Greenland Current and the North Atlantic Current and explained 34% of the total variance. In the first PC, there was a clear increase until 2016. Four control factors for SSS in the Nordic Sea were also assumed: 1) inflow land freshwater (river discharge/glacial melt), 2) evaporation and rainfall, 3) sea ice melt, and 4) ocean currents. Each factor was examined to see how correlated with changes in SSS in the Nordic Sea. Studies of salinity changes in the Nordic Sea are expected to play an important role in understanding the relationship between the global warming and AMOC change.

Poster Presentation | P1 10

Impact of Antarctic meltwater forcing on East Asian climate under greenhouse warming

Ji-Hoon Oh

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ABSTRACT

In recent decades, Antarctic ice sheet/shelf melting has been accelerated, releasing freshwater into the Southern Ocean. It has been suggested that the meltwater flux could lead to cooling in the Southern Hemisphere, which would retard global warming and further induce a northward shift of the Intertropical Convergence Zone (ITCZ). In this study, we use experimental ensemble climate simulations to show that Antarctic meltwater forcing has distinct regional climate impacts over the globe, leading in particular to regional warming in East Asia, which offsets the global cooling effect by the meltwater forcing. It is suggested that Antarctic meltwater forcing leads to a negative precipitation anomaly in the Western North Pacific (WNP) via cooling in the tropics and the northward shift of the ITCZ. This suppressed convection in WNP induces an anticyclonic flow over the North Pacific, which leads to regional warming in East Asia. This hypothesis is supported by analyses of inter-ensemble spread and long-term control simulations.

Poster Presentation | P1 11

Long-term change and impact analysis of net radiation over Arctic

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ABSTRACT

Arctic is key parameter for understanding of climate change. Arctic amplification in which the temperature rises 2-3 times more than mid-latitude has been linked to various arctic climate feedbacks. Especially radiative flux is a variable that connects the feedbacks, it is important to understand how it changes. We analyzed a net radiation over arctic to understand the impact on climate change. The research is divided two parts; the first part is the long-term change of net radiation and the second is an analysis of the radiative flux factor that has the greatest influence on net radiation. We used the two types data such as reanalysis data as The Fifth-Generation ECMWF Atmospheric Reanalysis (ERA5) and satellite data as Clouds And The Earth's Radiant Energy System Energy Balanced And Filled (EBAF). Net radiation of ERA5 indicate the positive trend (1.4 W/m2/decade) during study period, on the contrary, EBAF data indicate negative trend (-1.0 W/m2/decade) during same period. We performed analysis of characteristics and impact using relative error to analyze what factors cause this difference. The variables that showed a large difference between the two data were shortwave upward and longwave downward radiation. Shortwave upward radiation controlled the intensity of net radiation trend, and ERA5 and EBAF indicate a relative error of about 165%, 101% respectively. Longwave downward radiation controlled the trend of net radiation, and ERA5 and EBAF represent a relative error of about 138%, 85% respectively. Since different trends occur depending on the data, it is necessary to select the appropriate data when using it for a model input. When observing long-term climate change in the Arctic, we need to focus on longwave downward radiation.

Poster Presentation | P1 12

Biological carbon pump processes in the sea ice-affected region of Antarctica

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ABSTRACT

The biological pump, a process that exports particulate organic carbon (POC) from marine primary production (PP) in surface waters to the deep ocean interior, is a crucial for sequestration of atmospheric CO2. The Southern Ocean is estimated to account for more than a quarter of global export by the biological pump, and thus the Antarctic environment and biosphere play an important role in the global carbon cycle and are highly sensitive to environmental change. It is presently unclear how on-going climate change will affect, for example whether the Antarctic region will become more extensive and more productive with polynya and sea ice productivity, or evolve to more open ocean conditions with low productivity. A lack of data due to logistical challenges and observational constraints limit our current understanding of the biological pump system in the Antarctic, limiting our ability to predict impacts on CO2 sequestration. We compiled and standardized sediment trap data from 51 sites in the Antarctic realm above 40 °S to infer the implications of biological carbon pump system and predict the response of Antarctic polynyas to climate change. We also distinguished surface sea ice condition: ice-free zone (open ocean and polynya), marginal sea ice zone, seasonal ice zone, and perennial/permanent sea ice covered zone. This study is expected to help to resolve one of the most pressing questions on the Antarctic realm, and further our understanding of carbon and biogeochemical cycling in this under-sampled, yet rapidly changing, oceanographic region.

Poster Presentation | P1 13

Carbon dioxide and methane fluxes measurement near tundra ponds ecosystems in Cambridge Bay, Canada

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ABSTRACT

Considering that 25% of Earth's terrestrial surface is underlay by permafrost, warming permafrost may play important roles in carbon cycle of the polar region. The carbon flux in tundra ecosystems should be monitor in order to evaluate the potential future sensitivity of the carbon cycle to climate change. In this study, CO2 and CH4 fluxes were measured in tundra ecosystem using eddy covariance methods and chamber systems during summer in 2019 in Canada. The study site is located on dry tundra with ponds in high-arctic near Cambridge Bay, Nunavut, Canada (69°7'47.7"N, 105°3'35.3"W).CO2 and CH4 fluxes near ponds in permafrost were examined to understand the mechanism of the carbon cycle over the tundra ponds ecosystems. This study was supported by a National Research Foundation of Korea grant from the Korean government (MSIP) (NRF-2021M1A5A1065679 and NRF-2021R1I1A1A01053870)

Poster Presentation | P1 14

Assessment of radiative forcing with sea ice changes over arctic using radiative kernels

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ABSTRACT

Arctic sea ice has changed at a rapid rate since the 1990s. This trend not only accelerates Arctic warming but has a profound effect on atmospheric systems. Many studies have used the kernel to quantitatively evaluate the Influence on the TOA(Top Of Atmosphere) from changes in the surface. In this study, we use the radiative kernels (Hadley Centre Global Environmental Model2 (HadGEM2), HadGEM3-GA7.1, Community Earth System Model (CESM)-Community Atmosphere Model5 (CAM5)) to calculate radiative forcing according to changes sea ice in Arctic and analyze the spatial-temporal characteristics of radiative forcing. We used the Northern Hemisphere EASE-Grid 2.0 Weekly Sea Ice Extent data to identify changes in sea ice. To calculate the radiative forcing by albedo, we used the surface albedo kernel and AVHRR-based CLARA-A2 (CM SAF cLoud, Albedo and surface RAdiation dataset Edition2) Albedo data. The surface temperature kernel and ice temperature layer 0 data of the ERA5 (the fifth generation ECMWF reanalysis for the global climate) monthly averaged data were used to calculate the radiative forcing by the surface temperature. As a result of the study, the albedo-based radiative forcing tended to increase, and the temperature-based radiative forcing tended to decrease. However, different characteristics appeared depending on the sea area and season.

Poster Presentation | P2 01

Basal reflectivity and scattering of Thwaites Glacier, West Antarctica

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ABSTRACT

Thwaites Glacier is considered to be an important indicator of the West Antarctic Ice Sheet's instability and portends the magnitude and rate of sea level rise. Inter-related processes of subglacial hydrology, basal substrate distribution, and grounding zone retreat are informed through the mapping of subglacial topography and characterizing basal conditions with radar echo sounding. New radar data collected over Thwaites Glacier as part of LIONESS-TG in 2020 is put in the context of past radar surveys, the 2004 survey by University of Texas - Institute for Geophysics and the 2012-2018 surveys by NASA's Operation Ice Bridge, to describe in more detail the basal environment in the near grounding zone of Thwaites Glacier and observe changes to this important region.

Poster Presentation | P2 02

Autonomous Underwater Glider Observations of Eddy-Driven Transport at the Edge of the Nansen Ice Shelf

Drew Friedrichs

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ABSTRACT

Understanding circulation surrounding Antarctic ice shelves is a focus of current literature due to the Southern Ocean's role the production and export of ice shelf meltwater. Thanks to improvements in detailed observations and circulation models, there is a now greater understanding of how coastal circulation interacts with ice and meltwater at both small and large scales. Insights into intermediate scale phenomena, however, remains rare. Here, we present autonomous glider observations of a 10 km-wide sub-mesoscale eddy at the edge of an Antarctic ice shelf in the East Antarctic (Ross Dependency). It is in approximate geostrophic balance, indicating that the resulting ocean currents can be predicted. This feature dominated the coastal circulation in the region, promoting a deepening of warm surface water, an upwelling of dense deep water, and an increase in turbulent mixing throughout the water column. We suggest that mesoscale eddies such as this reliably form along cold-cavity ice shelves and their impacts on the transport of heat and meltwater at the ice edge cannot be ignored.

Poster Presentation | P2 03

Changes of Campbell Glacier Tongue in East Antarctica observed with satellite SAR

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ABSTRACT

Campbell Glacier is an outlet glacier located in Northern Victoria Land, East Antarctica, and is discharged into Terra Nova Bay through Campbell Glacier Tongue. Long-term change of the Campbell Glacier Tongue is closely related to the changes in the marine environment of the Terra Nova Bay, and is recognized as a key indicator of climate change. In this study, the changes in the area, ice flow velocity, and grounding line of the Campbell Glacier Tongue over the past 25 years were analyzed by using satellite synthetic aperture radar (SAR) data. ERS-1/2 SAR (19962000), ENVISAT Advanced SAR (2006-2010), ALOS Phased Array type L-band SAR (2006-2010), COSMO-SkyMed SAR (2010-2013, 2019), and Sentinel-1 SAR (2015-2020) images were acquired for the Campbell Glacier Tongue. The boundary of the glacier tongue was extracted from the time-series SAR images based on visual inspection, from which the change of area was analyzed. Ice flow velocity of the glacier tongue was estimated by using the offset tracking of the SAR images, and the grounding line was extracted by applying double-differential interferometric SAR technique to the ERS-1/2 and COSMO-SkyMed one-day tandem SAR image pairs. The area of the Campbell Glacier Tongue was observed to be 88 km2 in 1996 and decreased to 70 km2 in January 2018, which corresponds to a 20% reduction in the area. Since 2018, the area of the glacier tongue has increased, but the increase was only 2 km2. Ice flow velocity of the glacial tongue has increased from 140 (grounding line)-240 m/yr (ice front) in 1996 to 180-280 km/yr in 2020, and the position of the ground line retreated approximately 1-3 km for the past 25 years.

Poster Presentation | P2 04

Changes in the relative sea-level (RSL) of the Gulf of Dvina (White Sea, north-western Russia))

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ABSTRACT

The study is devoted to the reconstruction of changes in the relative level of the White Sea in the Holocene in the area of the Dvina Bay (Onega Peninsula, northwestern Russia). Although the eastern coast of the White Sea has investigated quite well, the new paleolimnological data on RSL changes is important for constraining regional paleogeographic reconstructions, understanding the patterns of development of coasts on the periphery of Late Pleistocene ice sheets, and verifying models of RSL dynamics. Objects located at different hypsometric levels were selected for the research:Lake Maloye Murakanskoye (10.9 m a.s.l.), Lake Zhirovskoye (9.5 m a.s.l.), Lake Murakanskoye (7 m a.s.l.) and the Gorbovatiy Mokh bog (6.5 m a.s.l.). Lithological, diatom, grain size, geochemical, and radiocarbon analyses on four sediment cores were conducted for this study. This work allowed us to provide detailed information about the transgressive–regressive stages of the White Sea in the Holocene; however, the questions of the time of the beginning of the Post-glacial transgression and its maximum level remain unanswered. The regression of the Early Holocene occurred earlier than 10.4-10.1 ka cal BP from an altitude of 10.9 m a.s.l.sea-level and earlier than 9.46-9.09 ka cal BP from an altitude of 7 m a.s.l.. In the beginning, the regression was rapid, but in the final stage was gradual. The relative sea-level decreased at a rate of 0.4 cm/year. The Middle Holocene transgression began at about 8.5-8.4 ka cal BP and its highest level did not exceed 9.5 m in the study area. The completion of Tapes occurred about 3.9 ka cal BP from a height of 7 m a.s.l. sea-level and 2.4 ka cal BP from an elevation of 6.5 m a.s.l. Acknowledgements The research was carried out with the financial support of the Ministry of Education of the Russian Federation (project No. FSZN2020-0016) (paleolimnological research), the RFBR project 19-05-00966 (geomorphological research), the implementation of grain-size and geochemical analyses were realized by the KOPRI fellowship 2019 support, State Program of Laboratory of geoecology of the North, Department of Geography, Lomonosov State Moscow University (diatom analysis), the Program of Strategic Academic Leadership of the RUDN (GPR research).

Poster Presentation | P2 05

Multi-layer structures of meltwater plume near grounding line, Antarctica

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ABSTRACT

Loss of Antarctic ice sheet is accelerating by basal melting at ice shelf, rapid retreat of grounding line and atmospheric forcing with global warming, threatening our lives via global sea-level rise. To determine the cause of basal melting, we have to investigate the fundamental physics of the ocean and its interaction with the ice shelf using a validated numerical approach with in situ observations. In this study, we explore the flow physics of meltwater plume near the grounding line and reveal the detailed structures of stabilizing force of meltwater at locations near the grounding line and far from the grounding line. To resolve the meltwater plume and threedimensional flow field, we employ the large eddy simulation with a three equation model for basal melting. Through sensitivity study for the velocities of ocean currents, we determine that meridional velocity (perpendicular to grounding line) which can determine the tidal front location affects the vertical depth of the meltwater, whereas zonal velocity (parallel to grounding line) affects buoyant properties of meltwater, such as temperature and salinity. The stabilizing force of meltwater near the grounding line has a thin and single layer, whereas that far from the grounding line has a thick, multi-layer structure that can prevent the vertical entrainment of heat contents. Due to multi-layer structures of stabilizing force, there is turbulence collapse at the depth of high stabilizing force.

Poster Presentation | P2 07

Subglacial morphology and hydrology in the 60E – 100E coastal sector of East Antarctica

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ABSTRACT

The sector of 60E – 100E (Mac. Robertson, Princess Elizabeth, Wilhelm II, and Queen Mary Lands, East Antarctica) is the cornerstone for understanding glaciation, bedrock, and tectonic evolution of a large area of East Antarctica. Located there is the Lambert Deep, one of the longest rift systems of Antarctica, which extends from the southern Prince Charles Mountains via Prydz Bay to the continental edge for about a thousand kilometers. Lambert Deep is partially covered by Lambert Glacier, the largest outlet glacier on our planet, and the Amery Ice Shelf, which is the third ice shelf in the world. The talk will present a compilation of the bedrock topography and the ice thickness data collected during Russian and Soviet Antarctic expeditions in the 60E – 100E coastal sector of East Antarctica since the 1970s. A subglacial morphological chart demonstrating the structure and the main features of the bedrock will be also presented. In addition, we will consider the issue of basal melting and the formation of subglacial lakes, streams, and the hydrological network within the study area. Note that, based on the results of radio-echo sounding and remote sensing, some subglacial lakes, including Pionerskoe, Komsomolskoe, Lambert1, were revealed in this region. Additionally, the results of modeling basal melting or freezing and hydrological pathways will be presented. This scientific work was supported by the Russian Foundation for Basic Research grant No 20-05-00343.

Poster Presentation | P2 08

A high-resolution process study of High Salinity Shelf Water formation in the Terra Nova Bay Polynya, Ross Sea, Antarctica

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ABSTRACT

Polynyas are large, seasonal openings in sea ice that allow for the transfer of momentum, gas, and heat between the atmosphere and an ocean otherwise sealed off by ice. Coastal Antarctic polynyas formed by strong offshore winds are of particular importance because they are sites of high salinity shelf water (HSSW) production, wherein continuous sea ice production forms salty, dense surface water. HSSW sinks and is transported off the continental shelf, contributing significantly to the makeup of Antarctic Bottom Water (AABW), a water mass that drives the overturning of ocean nutrients, carbon, and heat on a global scale. AABW has been observed in the past several decades to be warming and freshening, and the future of it and its constituent water masses in a changing climate is uncertain. Despite its importance to our understanding of AABW, HSSW production is not well constrained, highlighting the need for comprehensive and high-resolution observational studies of this complex Antarctic air-ice-ocean system. Here, we present analysis of data from a mooring uniquely instrumented to capture upper-ocean processes surrounding HSSW formation in the Terra Nova Bay Polynya in the western Ross Sea. This mooring was unprecedented in its in-situ measurements of the near surface (~50m water depth) during the austral winter, when HSSW formation occurs. We identify polynya opening events using both in-situ measurements of sea ice thickness and satellite imagery, and characterize how the resulting HSSW production evolves over the course of the year, on scales from seasonal to hourly. Additionally, we calculate an updated estimate of HSSW production rate in the Terra Nova Bay Polynya.

Poster Presentation | P2 09

An east-west contrasting salinity change of Antarctic Bottom Water in the Indian sector of Southern Ocean over recent decades

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ABSTRACT

Physical properties of Antarctic Bottom Water (AABW) derived from mixture of multiple source waters of different properties, are significantly affected by and contribute to the climate change. This study reveals a contrasting east-west pattern of changes in AABW temperature and salinity in the Indian sector of Southern Ocean or Southern Indian Ocean (SIO), which became warmer (0.04 ± 0.01 °C/decade) and more saline (0.002 ± 0.001 kg/g/decade) in the western SIO whereas warmer (0.03 ± 0.01 °C/decade) and fresher (-0.004 ± 0.001 kg/g/decade) in the eastern SIO in the last decade, as found from repeated hydrographic observations along meridional lines (1993, 1996, and 2019 in the western SIO, and 1995 and 2012 in the eastern SIO). The warming and salinification of AABW consisting of the Cape Darnley Bottom Water (CDBW), Weddell Sea Deep Water (WSDW), and Lower Circumpolar Deep Water (LCDW) in the western SIO, are explained by changing mixing ratios among source waters between 1999s and 2010s, e.g., decreasing portion of relatively fresh CDBW (from 68% to 59%), and increasing portions of saline WSDW (from 30% to 34%) and warm and saline LCDW (from 2% to 7%). In contrast, in the eastern SIO, the warming and freshening of AABW consisting of the Ross Sea Bottom Water (RSBW), Adélie Land Bottom Water (ALBW), and LCDW are not explained by the changing mixing ratios among but properties of the source waters between 1990s and 2010s, e.g., warming and freshening of RSBW (0.08°C/decade and -0.013 kg/g/decade) and ALBW (0.01°C/decade and -0.008 kg/g/decade). The east-west contrasting pattern of AABW salinity change (eastern freshening and western salinification) in addition to the overall warming over the decades has important consequences within and beyond the SIO, such as global meridional overturning circulation (enhanced deep northward geostrophic current from the Southern Ocean to Indian Ocean with a magnitude from 1.9 in 1990s to 2.5 cm/s in 2010s), thermosteric and halosteric sea level rise (up to 2.4 cm in the western SIO to 2.0 cm in the eastern SIO), among others.

Poster Presentation | P3 02

Autonomous zooplankton profiler reveals the changing dynamics of zooplankton during a summer-winter-summer transition in the very high-Arctic

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ABSTRACT

With rapid sea-ice decline, ocean warming and increasing Atlantic inflow, the ecosystem of the Central Arctic Ocean (CAO) is experiencing an unprecedented, disruptive transformation. While this transformation is affecting the biodiversity of marine communities and the ecosystem functions they fulfil, major knowledge gaps about the distribution of pelagic macrofauna (zooplankton and fish) complicate the assessment of the impact of this transformation on biodiversity and marine resources. The largest blind spot remains in the central Arctic Basin, which has been difficult to sample with large sampling gear such as fishing nets due to a yearround ice coverage. However, in the face of increasing human activities and international efforts to implement marine management in the CAO, it becomes important to monitor pelagic fauna in remote areas, such as the CAO. One possibility to enable a better sampling of pelagic macrofauna is to use autonomous observatories drifting across the CAO with the sea ice. To fill this gap, the EcoLight team developed an autonomous sea-ice observatory comprising a new autonomous Acoustic Zooplankton and Fish Profiler (AZFP). The device has 4 frequencies targeting different size classes of animals. It samples automatically at predefined intervals and transmits the data in near real time to our home institutes via Iridium. Importantly, this system allows us to change the sampling parameters via a remote connection at any time. The AZFP buoy was deployed at the North Pole in September 2020, shortly before the end of the MOSAiC expedition. Since then, the device has been recording the vertical zooplankton distribution over the entire winter season as it drifted from the North pole to the top of Greenland. This included the little studied polar day-polar night-polar day period. We show the results from this remarkable dataset.

Poster Presentation | P3 03

Is the Primary Production in the Antarctic polynya system declining?

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ABSTRACT

Primary production in Antarctic polynyas has been consistently changing over the past few decades with synoptic and local forcings, such as changes in sea ice caused by climate variability, thereby profoundly modulating the Antarctic marine food web and biogeochemical cycles. Despite the importance of primary productivity, information on both how it has changed and where it is going is still lacking. Here, we analyze multitemporal variations and trends in primary productivity within the Antarctic polynya system to answer the following questions: How has primary productivity in the polynya system changed? What environmental factors are mainly associated with these changes? Our results show that primary productivity within most of the Antarctic polynya system, excluding the Ross Sea, significantly declined from 1997/1998 to 2019/2020 in the austral spring- and summer-time. These declines could be mainly explained by the reduced light availability of phytoplankton, inducing by the combination of clouds and weakened initial light incident at top-of-atmosphere.

Poster Presentation | P3 04

Estimation of Arctic basin-scale total freeboard from passive microwave satellite

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ABSTRACT

We attempted to estimate the total freeboard, the height of snow top on sea ice from the sea surface, on Arctic basin-scale by using multiple linear regression method. For developing regression equation, brightness temperatures from passive microwave sensor, Advanced Microwave Scanning Radiometer (AMSR) 2, and the total freeboard from satellite altimeter, Ice, Cloud, and Land Elevation Satellite (ICESat)-2 during two winter seasons was collected. Then all data was collocated to match spatio-temporal resolution. By utilizing the different sensitivities of microwave frequencies on freeboard height of ice and the depth of snow, the regression based on the gradient ratio (GR) of brightness temperatures was devised. The relation between total freeboard and two GRs clearly shows that the combination of two GRs can be linked to the total freeboard of sea ice. and then, a multiple linear regression equation using two GRs as input variables was developed and monthly regression coefficients were calculated. The estimated monthly total freeboard shows the expected geophysical distribution and the evolution of sea ice during the winter-spring season over the Arctic. Evaluation of regressed total freeboard with OIB total freeboard in March of 2013, 2014, 2015, and 2017 shows the fine result of R = 0.765 and RMSE = 10.8 cm, despite different spatial resolution and independent time domain from training data. The results of this study can be applied to not only the sea ice thickness estimation but also the assessment of altimeter-measured freeboard or prescription data for boundary conditions of the model simulation.

Poster Presentation | P3 06

Flexural Strength of the Arctic Sea Ice: A Case Study in the Barents Sea

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ABSTRACT

Flexural strength is a mechanical property of ice defined by the maximum strength applied before breaking. Historically, the strength depends on its brine volume, which is expressed by a function of salinity and temperature. This study estimated the flexural strength of the Arctic sea ice in the Barents Sea during the period 2011-2020 using ice thickness and surface temperature. CS2SMOS merged sea ice thickness and 2m temperature from ERA5 reanalysis data were utilized. For validation and analysis, the average strength in the regions of interest where the field campaigns were carried out during the period 1996-2006 was compared. The difference between the decadal averages was relatively small. The annual averages showed an increasing trend; however, a longer time series would enhance the trend. Finally, sea ice motion and extent must be considered for interpretation of the temporal variations.

Poster Presentation | P3 07

Spatial distribution of krill(Euphausia superba and E.crystallorophias) in the Terra Nova Bay polaynya and Ross Sea polynya during summer 2020

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ABSTRACT

Antarctic krill(Euphausia superba) and crystal krill(E.crystallorophias) are key mid-trophic level species, connecting primary producers and the upper trophic levels in the Ross Sea, which is the world's largest marine protected area. Since estimating of krill abundance and its vertical distribution is crucial to understand Antarctic ecosystem, its monitoring is vital. An acoustic survey was conducted to estimate distribution of both krill species in the Terra Nova Bay polynya(TNBP) and the Ross Sea polynya(RSP) on 6 – 21 December 2020. Antarctic krill and crystal krill were identified in acoustic data using multi-frequency identification windows (Sv12038 kHz and Sv200-120 kHz) and converted to krill density using the Stochastic Distorted-Wave Born Approximation target strength model. The response of acoustically determined weighted mean depth(WMD) was calculated to estimate vertical distribution of both krill species. The density of Antarctic krill ranged between 0 and 38.8 g/m^2 and that of ice krill ranged between 0 and 761.7 g/m^2, observed their distributions were highly skewed with many zero observations. Antarctic krill was detected in the northern part of the western RSP area and dense swarms of crystal krill were observed widely in TNBP and RSP areas. The WMDs of Antarctic krill and crystal krill ranged over 16 – 215 m and 16 – 180 m, respectively and crystal krill was in general distributed deeper than Antarctic krill. This study presented a procedure that classifies between Antarctic krill and crystal krill acoustically, and estimated their density and vertical distribution. This results will helpful in understanding Antarctic ecosystem in Ross Sea.

Poster Presentation | P3 08

Seasonal Variability of Minimum Brightness Temperature at the 6.925 GHz Band of AMSR2 for the polar Oceans

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ABSTRACT

The minimum brightness temperature (mBT) of seawater in the polar region is an essential parameter in algorithms for determining sea ice concentration or snow depth. We collected brightness temperature and sea ice concentration data from the Advanced Microwave Scanning Radiometer 2 (AMSR2) for eight years from Jul 2012 to June 2020. We estimated mBT at 6.925 GHz for the Arctic and Antarctic Oceans. There is a significant difference in the seasonal variability. To find their physical characteristics in the seasonal variability of seawater mBT at 6.925 GHz, We calculated the mBT with the radiative transfer model parameterized by sea surface temperature (SST), sea surface wind speed (SSW), and integrated water vapor (IWV). The estimated mBT represents the mBT simulation under 2–5 m/s SSW and SST below 0 °C, except in the Arctic summer. The exceptional mBT in the Arctic summer was related to unusually high SST, which can be evidence of arctic amplification in the seasonal variability of Arctic mBT.

Poster Presentation | P3 09

The Response of the Nordic Seas to Wintertime Sea-ice Retreat

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ABSTRACT

The ocean response to wintertime sea-ice retreat is investigated in the coupled climate model HiGEM. We focus on the marginal ice zone and adjacent waters of the Nordic Seas, where the air-sea temperature difference can be large during periods of off-ice winds promoting high heat flux events. Both control and transient climate model ensembles are examined, which allows us to isolate the ocean response due to sea-ice retreat from the response due to climate change. As the wintertime sea-ice edge retreats towards the Greenland coastline, it exposes waters that were previously covered by ice which enhances turbulent heat loss and mechanical mixing, leading to a greater loss of buoyancy and deeper vertical mixing in this location. However, under global warming, the buoyancy loss is inhibited as the atmosphere warms more rapidly than the ocean which reduces the air-sea temperature difference. This occurs most prominently further away from the retreating ice edge, over the Greenland Sea gyre. Over the gyre the upper ocean also warms significantly, resulting in a more stratified water column and, as a consequence, a reduction in the depth of convective mixing. In contrast, closer to the coast the effect of global warming is overshadowed by the effect of the sea-ice retreat, leading to significant changes in ocean temperature and salinity in the vicinity of the marginal ice zone.

Poster Presentation | P4 01

Challenging Dynamical Forecast Systems with Spatial Damped Anomaly Persistence for the Sea-Ice Edge

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ABSTRACT

Accelerated loss of the sea-ice cover and increased human activities in the Arctic highlight the need for meaningful prediction of sea-ice conditions at sub-seasonal to seasonal time scales. There is a large variety in the predictive skill of dynamical forecast systems, which can be benchmarked against reference forecasts based on present and past observations of the iceedge. However, the simplest types of reference forecasts – persistence of the present state and climatology – do not exploit the observations optimally and thus lead to overestimation of forecast skill. For spatial objects such as the ice-edge location, the development of dampedpersistence forecasts that combine persistence and climatology in a meaningful way poses a challenge. We have developed a method that combines the climatologically derived probability of ice presence with initial (present) anomalies of the ice edge. We have tested and optimized the Spatial Damped Anomaly Persistence method based on minimization of the Spatial Probability Score, using observed as well as idealized model data. The damping of persistence takes into consideration the temporal pattern of re-emergence and predictability of ice-extent in the Arctic. The resulting reference forecasts provide a challenging benchmark to assess the added value of dynamical forecast systems.

Poster Presentation | P4 02

Development of an Unmanned Ground Vehicle for Detecting Hidden Crevasses

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ABSTRACT

The Korea Polar Research Institute(KOPRI) is developing “Korean Routes” to support the activities in the unexplored fields of Antarctica. The snow covered crevasses around the route threaten the safety of the traverse fleet. We have developed an unmanned ground vehicle(UGV) that allows unmanned exploration of dangerous areas to ensure safe travel from these crevasses. In order to overcome the harsh terrain of Antarctica, the vehicle features over 25cm ground clearance, four-wheels each powered by a 400W high-power motor, passive joints and differential links which enable to maintain four point contact in rough terrain. The control unit uses open-source hardware and software in consideration of rapid function implementation and ease of customization in the future. In November 2019, the UGV was successfully used to detect crevasses in the 2.6km section of the Browning Pass around Jang Bogo Station, Antarctica. Recently, in order to improve the maneuverability of the vehicle, a test device that can measure the strength of the snow and the vehicle’s traction has been manufactured. These efforts will contribute to expanding Korea’s polar research area to inland of Antarctica in the future.

Poster Presentation | P4 03

Spatial and Regional Intercomparision of the Total Ozone Column in Antarctica Continent based on Ground and Satellite-based Observations

Songkang Kim

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ABSTRACT

Efforts for the ground-based observation of the total ozone column (TOC) have been carried out for a long time, even in the Antarctic region where the field campaign is not easily conducted. The Brewer Spectrophotometer (Brewer), an instrument for observing TOCs on the ground, has been installed at several stations in Antarctica. In this study, we used TOC observations result of Brewer installed at King Sejong, Jang Bogo, and Zhongshan stations in Antarctica for the evaluation of five polar-orbit satellite instruments: Ozone Monitoring Instrument (OMI) and Atmospheric Infrared Sounder (AIRS) of Aqua satellite, TROPOspheric Monitoring Instrument (TROPOMI) of Sentinel-5 Precursor satellite, Global Ozone Monitoring Experiment (GOME-2) of MetOp satellite, and Ozone Mapping and Profiler Suite (OMPS) of Suomi-NPP satellite. Generally, the comparison between Brewer and multiple satellite TOCs showed a high correlation. But we found that the observation sensitivity of AIRS sensors was low during the austral spring period when the ozone hole typically occurs in Antarctica. In addition, we also used both Level 2 and 3 data for the analysis because the difference among satellite products were usually attributed to the spatial resolution. The difference in spatial resolution was relatively low compared to the degree of the difference between observation sensors appeared. From these results, it seems that it is necessary to selectively consider which satellite to use, rather than considering the observation resolution of the satellites for the diagnosis of TOC patterns in Antarctica.

Poster Presentation | P4 06

Decomposition of water dissolved organic pollutants using freezing activated HCO3−/PMS system

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ABSTRACT

The activation of peroxymonosulfate (PMS) has been intensively studied for advanced oxidation technology due to its versatile capability to decompose organic pollutants in water. Various activation technologies have been applied to enhance the oxidative characteristic of PMS, but most of them need energy consumption to operate the system or the removal of catalytic materials from the system. On the other hand, natural abundant bicarbonate and carbonate ion (HCO3−, CO32−) have been found to activate PMS moderately. This method has benefits because the reaction occurs spontaneously and the reactants are not needed to separate from the system, so eco-friendly. In this study, we demonstrate the reaction of the HCO3−/PMS system can be accelerated by freezing. More than 90% of the initial 4-chlorophenol (4-CP) decomposed in the frozen case, whereas only less than 20% of the 4-CP was removed in the aqueous case at the same time. We attempted to determine the reason for this enhancement as it is not common knowledge. The oxidation mechanism was investigated by testing plausible scenarios including base activation and the generation of single oxygen molecules and radical species. We also investigated the characteristics of the reaction such as reactivity toward various substrates and the tendency to consume PMS. The results show the potential applicability of the freezing phenomenon, which occurs naturally in the mid-latitude and polar area, to help a decomposition of water dissolved organic pollutants by the imitation of the natural purification process.

Poster Presentation | P5 01

Bacterial Community Structure of Surface Snow in Antarctica

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ABSTRACT

In recent years, applications of molecular methods to study microbial ecology have allowed the extension of our knowledge that extreme environment contains unexpected high diversity of bacteria and their complex of community. Recently, a metagenomic study of snow suggested that snow bacteria can be adapted to photochemical reactions and oxidative stress in addition to cold stress, and therefore may form specific communities. In this study, we investigated the bacterial communities in Antarctic surface snow based on culture-dependent and –independent approaches. Total 13 samples were collected from November in 2015 to January in 2016 around Victoria Land (East Antarctica). A total of 8 strains belonging to either Actinobacteria or Firmicutes were isolated from two samples. On the basis of 16S rRNA gene by pyrosequencing, overall 12,456 sequence reads were obtained, and 254 operational taxonomic units (OTUs) were generated with 97% similarity cutoff. Gammaproteobacteria (0.0~70.1%), Actinobacteria (1.9~67.8%), Firmicutes (0.0~45.8%), and Alphaproteobacteria (0.5~22.9%) were dominant. The dominant genera such as Propionibacterium, Aerococcus, and Micrococcus may have been deposited on the snow surface from the atmosphere. In contrast, genus Enhydrobacter may be considered most abundant as endogenous Antarctic snow inhabitants. These findings can get closer to the snow ecosystem, which occupy over a third of land surface area.

Poster Presentation | P5 02

Mathematical modelling of the rapid draining of lakes and the formation of an ice depression on Dålk Glacier (Larsemann Hills, East Antarctica)

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ABSTRACT

Antarctic stations and field bases are the main elements of the infrastructure of Antarctic expeditions, in the areas where annual all-year and summer investigations are carried out. In particular, many Russian Antarctic stations are characterized by intensive logistic work that demands special attention for questions of studying hazardous hydrological and glaciological processes. The instability of the glacier-impounded and intraglacial lakes in Antarctic oases has been known since the construction of the first stations and field bases. Even though some events had drastic consequences, little attention has been paid to the study of such active lakes. In this study, we will focus on the recent flooding in the Larsemann Hills. The catastrophic outburst flood occurred on the afternoon of 30th January 2017. The rapid drainage of both a thin supraglacial layer of water (in the area of Boulder Lake) and Lake Ledyanoe into the intraglacial Lake Dålk provoked its overfill and outburst. As a result, a depression of 183×220 metres was formed in the place where Lake Dålk was located. In this talk, we will provide an overview and clarify the current state of knowledge on this flood. Mainly, we investigate the reasons and consequences of the drainage of the system of lakes Boulder, Ledyanoe, and Dålk. Our research is based on the results of three-year (2017-2019) field studies and the mathematical modelling of the drainage of each of the lakes. The variety of investigations included GPR soundings of lakes and the glacier, core drilling of the upper part of the glacier, measurements of glacier heights, and velocity of its current. The applied model is based on a numerical solution of the system from the continuity equation and the conservation of energy and is suitable for assessing both open and intraglacial drainage. As a result, we specified the reasons for the outburst of the system of lakes Boulder, Ledyanoe, and Dålk and compiled a phenomenological model of depression formation. In addition, we carried out mathematical modelling of the outburst of each of the three lakes and estimated the flood severity. Outburst hydrographs, channel diameters, volume and duration of floods were calculated. Particular simulation results were validated with field data. In conclusion, we give an overview of the new outburst of the lake system, which began in 2020 with the drainage of the lakes Boulder and Ledyanoe and the new formation of Lake Dålk. This scientific work was supported by the Russian Foundation for Basic Research grant No. 20-05-00343.

Poster Presentation | P5 03

Effect of Antifreeze Proteins from the Arctic Yeast Leucosporidium sp.AY30 on Freezing-enhanced Oxidation of Iodide by Hydrogen Peroxide

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ABSTRACT

Ice-binding proteins (IBPs), originating from Arctic or Antarctic microorganisms, have freezing inhibitory characteristics, allowing these organisms to survive in the polar regions. Still, the mechanism by which IBPs influence chemical reactions in ice by controlling the formation of ice crystals has yet to be reported. We suggest a new iodide (I–) activation mechanism to generation of triiodide (I3–) by hydrogen peroxide (H2O2) in ice with IBPs. In the presence of Arctic-yeast-originating ice-binding extracellular glycoprotein (LeIBP), isolated from Leucosporidium sp.AY30, a significant increase in iodide activation was observed. Further increase in the I3– concentration was also observed with the introduction of H2O2 to the frozen solution, and the reaction in the ice increased with an increase in LeIBP concentration. The insitu pH measurement in ice using cresol red (CR) revealed proton accumulation into the ice grain boundaries by LeIBP, however, the presence of LeIBP did not influence the acidity of the ice. The enhanced freeze concentration effect of H2O2 by LeIBP indicated that larger ice crystals were formed in the presence of LeIBP. The results suggest that LeIBP affects the formation and morphology of bulk ice crystals, thereby reducing the overall volume of ice boundaries throughout the ice. This leads to an increased local concentration of iodide ions and H2O2 within the ice grain boundaries. IBP-assisted production of gaseous iodine in a frozen environment provides a mechanism for previously unrecognized formation of active iodine species in polar regions.

Poster Presentation | P5 04

Rigidity condition for the hyper-activity of ice binding protein and implication for polar microbial survival

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ABSTRACT

Ice binding proteins (IBPs) are well-characterized proteins for the cold-adaptation mechanism of microorganisms from the polar region. Our lab previously invested two ice-binding proteins, FfIBP from Antarctic bacteria Flavobacterium frigoris PS1 and LeIBP from Arctic yeast Glaciozyma sp.. Although two ice-binding proteins share a highly sequential and tertiary structure similarity, thermal hysteresis (TH) activity of FfIBP is ten times higher than that of LeIBP, so that FfIBP can be classified as hyper-active IBP. We concluded that the hyper-activity of FfIBP is originated from residual composition on ice-binding site (IBS), more extensive surface area of FfIBP to the ice, and capping head loop region for protein stabilization. Despite extensive structural investigation on IBPs and antifreeze proteins (AFPs), little evidence considering the relation between protein stabilization and TH activity has been elucidated. Here, we investigate the important rule of head capping region and stabilization for the hyper TH activity using FfIBP, chimeric IBP named as mFfIBP, and C107S structure by molecular dynamics (MD) simulation. Data comparison reveals that immobility of the residue movement on IBS of FfIBP is the crucial factor for the hyper TH activity. On the basis of these simulation analyses, we propose the structural stabilization is important as one of the necessary conditions to be hyper-active for IBPs. Moreover, in the physiologic condition mimicking ice habitats, bacterial forms brine pockets in the presence of the membrane-bound IBPs with TH activity-dependent manor. Increased brine pockets caused by cells with higher TH active IBPs may be beneficial to bacterial survival in the cold environment. The newly identified condition for the hyper TH activity of IBPs and the implication of hyper-activity provide insight into the mechanistic aspects for cold adaptation of microorganisms from the polar region.

Poster Presentation | P5 05

Study on the impact of climate change on Antarctic plant-pathogen interactions

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ABSTRACT

Study on the impact of climate change on Antarctic plant-pathogen interactions Hongshi Jin1, Jungeun Lee1,2,* 1Division of Polar Life Sciences, Korea Polar Research Institute (KOPRI), Yeonsu-gu, Incheon 21990, Republic of Korea 2Department of Polar Science, University of Science and Technology, Daejeon 34113, Republic of Korea "Global warming" is a steady increase in the overall temperature of the Earth's atmosphere. From the points of view of plant biomass, the predicted pattern for global warming will undoubtedly increase plant productivity by prolonging the growing period. However, as the temperature rises, pathogen growth is expected to increase, and furthermore, recent molecular biological results have predicted that small fluctuations of temperature may make plants more susceptible to pathogenic diseases. The West Antarctic Peninsula is a tipping point where the effect of global warming appears fastest on the planet, and vegetation changes occur rapidly. Throughout the 2019-2020 expedition, plant samples with pathogenic symptom were collected from field sites. The study will identify the structure of endophytic pathogen groups, isolate each strain, and confirm the hosts' immune response against the isolated strains. In addition, the warming simulation test will demonstrate how these native extremophyte species exhibit immune responses to pathogens when the temperature rises. We expect that the results of this study to contribute to explaining the impact of climate change on Antarctic plant-pathogen interactions.

Poster Presentation | P5 06

Classification of behaviors of South polar skua (Stercorarius mccormicki) breeders using acceleration and video data

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ABSTRACT

It is important to track behaviors of wild animals for ecological studies. Recent bio-logging techniques, such as accelerometers and video-cameras, allow us to access the body angles and locations. In this study, we deployed accelerometers and video-cameras to 10 South polar skua (Stercorarius mccormicki). From the acquired signals and video-recordings, acceleration patterns of each behavior were categorized by machine learning and manually checked by videorecordings. We expect that these results can contribute to reconstruct their behaviors.

Poster Presentation | P5 07

Soil microbiome in permafrost soils of Eastern Antarctica: functional and structural diversity, environmental factors

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ABSTRACT

Soil microbiological studies in Antarctica are still lacking in regard to investigation of taxonomic composition and functional diversity of microbiome. Moreover, increased rates of anthropogenic forcing (tourism activities, logistic load, functioning of the numerous scientific stations) require more attention to be paid, with specific studies dedicated to revealing the possible changes in microbiome due to anthropogenic transformation. This study is aimed to determine existing soil microbial communities, their relationship with soil parameters and the influence of anthropogenic activity in oases of Eastern Antarctica. The soil microbiome was investigated at different locations using 16S rRNA gene pyrosequencing. The taxonomic analysis of the soil microbiomes revealed 12 predominant bacterial and archaeal phyla—Proteobacteria, Actinobacteria, Acidobacteria, Chloroflexi, Gemmatimonadetes, Verrucomicrobia, Planctomycetes, Bacteroidetes, Armatimonadetes, Firmicutes, Cyanobacteria, Thaumarchaeota. Some specific phyla have been also found in sub-surface horizons of soils investigated. A significant correlation found between fine earth and microbial phylogenetic diversity further provides evidence of the vital role of gravel pavement, which creates favorable conditions for bacteria development in the harsh environments of Eastern Antarctica. Gravel pavement “shelters” the sub-surface horizons from dehydration, UV-radiation and strong winds, but simultaneously they are close to the surface, reachable by light and moisture from snow patches and well-insulated. This provides necessary conditions for fine earth formation and soil development. Moreover, our study also revealed that some bacterial species might be introduced into Antarctic soils by human activities. We also assessed the effect of different soil parameters on microbial community in the harsh environmental conditions of Eastern Antarctica. pH, carbon and nitrogen, as well as fine earth content, were revealed as the most accurate predictors of soil bacterial community composition.

Poster Presentation | P5 08

Characterization of novel polyethylene terephthalate-degrading enzyme (PETase) from the polar bacterium

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ABSTRACT

Poly(ethylene terephthalate) (PET) is widely used plastic products. But accumulation of PET waste in the environment is a tremendous threat in global, because PET waste are not completely biodegradable in nature. PET that has not been decomposed accumulates in the ocean, atmosphere and soil, causing harm to organisms. PET-degrading enzyme (PETase) which can hydrolyze PET, had been discovered from bacteria Ideonella sakaiensis 201-F6. Optimal temperature for enzymatic activity of PETase is 35~40℃. It makes a need of additional energy input in case of mass PET catabolic system. In this respect, proteins derived from polar organisms have the advantage of having a low activation temperature. In silico search of genome data in Polar and Alpine Micobial Collection (PAMC) of Korea Polar Research institute (KOPRI) found two PETase candidate orF. Candidates had the sequence and structural similarity with known PETase. Further experiments will verify the PET decomposition capacity of the two orFs and compare their reactivity at low temperatures.

Poster Presentation | P5 10

Structural and sequence comparisons of bacterial enoyl-CoA isomerase and enoyl-CoA hydratase

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ABSTRACT

Crystal structures of enoyl-coenzyme A (CoA) isomerase from Bosea sp. PAMC 26642 (BoECI) and enoyl-CoA hydratase from Hymenobacter sp. PAMC 26628 (HyECH) were determined at 2.35 and 2.70 Å resolution, respectively. BoECI and HyECH are members of the crotonase superfamily and are enzymes known to be involved in fatty acid degradation. Structurally, these enzymes are highly similar except for the orientation of their C-terminal helix domain. Analytical ultracentrifugation was performed to determine the oligomerization states of BoECI and HyECH revealing they exist as trimers in solution. However, their putative ligand-binding sites and active site residue compositions are dissimilar. Comparative sequence and structural analysis revealed that the active site of BoECI had one glutamate residue (Glu135), this site is occupied by an aspartate in some ECIs, and the active sites of HyECH had two highly conserved glutamate residues (Glu118 and Glu138). Moreover, HyECH possesses a salt bridge interaction between Glu98 and Arg152 near the active site. This interaction may allow the catalytic Glu118 residue to have a specific conformation for the ECH enzyme reaction. This salt bridge interaction is highly conserved in known bacterial ECH structures and ECI enzymes do not have this type of interaction. Collectively, our comparative sequential and structural studies have provided useful information to distinguish and classify two similar bacterial crotonase superfamily enzymes.

Poster Presentation | P5 11

Gut microbiota and diet composition of Muskox (Ovibos moschatus) by age using fecal and stable isotope analysis

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ABSTRACT

The gut microbiome plays important roles in host. In mammals, including human, microbiome is vertically transmitted by maternal lactation at birth. In this study, we investigated gut microbiome and diet compositions of muskox, a large herbivore in the high Arctic. From muskox feces in Ella Island, East Greenland, we compared the fecal microbiome with 16S bacterial primers and the dietary compositions with stable isotopes analysis between six adults and four calves. Both adults and calves shared Firmicutes (>75%). At family level, differences were detected: adults were dominated by Ruminococcaceae (= 73.75%), calves were dominated by both Ruminococcaceae (= 49.78%) and Lachnospiraceae (= 21.81%). Our NMDS results also showed differences between muskox by age. Stable isotope analysis on muskox feces and plants in the study area showed that adults and calves had similar ranges of δ13C (-29.15 ± 0.13) and δ15N (0.14 ± 0.36). Using stable isotopes mixing model, E.nigrum (34.6-39.3%) and S.glauca (25.6-25.9%) was detected as dominant diet of muskox. Our results suggested that the muskox adults and calves share different gut microbiome composition despite the similar diets.

Poster Presentation | P5 12

Ship noise effects on an Antarctic seal

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ABSTRACT

Marine mammals have been studies to be affected by underwater noises with behavioral and acoustic responses. In Antarctic environments, human activities is increasing for scientific purposes, fishery and tourism in the sea. However, ship noise effects in Antarctic waters have not been estimated on marine mammals. In this study, we investigated the vocal behaviors of leopard seals (Hydrurga leptonyx) near Jang Bogo Station at Terra Nova Bay using a passive auditory system for three consecutive years (2016-2018). Our results show that leopard seals exhibited no escape behaviors and their calling rates remained stable with the icebreaker approaches. These results suggest that Antarctic seals were not strongly affected by the icebreakers. Further studies should examine the vocal responses using a broader range recorders at individual levels.

Poster Presentation | P5 13

Recolonization of Adélie penguins (Pygoscelis adeliae) at Cape Hallett on Ross Sea, Antarctica

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ABSTRACT

The Adélie penguin (Pygoscelis adeliae) is common penguin species which breeds in Antarctic coastal areas. A large Adélie penguin breeding colony occupied at Cape Hallett (Antarctic Specially Protected Area no. 106) on northern Victoria land, Ross sea. However, joint scientific base station between United States and New Zealand was established in 1956 and abandoned in 1973. These anthropogenic activities are known to impacts on environment and create disturbances to wildlife species, as well as Adélie penguins at Cape Hallett. Here in, we compared the number of breeding pairs and spatial changes of nest distribution over time focused on station territory of three different breeding seasons, 1960 during the station period, 1983 before the station cleaning up and 2019 from aerial photograph. The Hallett station comprised 4.6ha within penguins favored area and identified 349 breeding pairs with nine subcolonies in 1960. Station territory was decreased to 4.2ha and 1683 breeding pairs were counted with 30 sub-colonies in 1983. The station district was re-inhabited by Adélie penguins, total 6175 breeding pairs with 86 sub-colonies in 2019. The results of the present study indicate confirmation on recolonization of Adélie penguin population and continuous species monitoring is needed to protect Antarctic ecosystem.

Poster Presentation | P5 14

Soil microbial co-occurrence network became less connected with the soil development along the glacier foreland of Midtre Lovénbreen, Svalbard

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ABSTRACT

Glacier forefields provide ideal conditions to understand the community assembly of early soil microbiota in primary succession. In this study, we investigated the bacterial and fungal communities in the retreating high-Arctic glacier Midtre Lovénbreen, Svalbard, aiming to understand how the ecological interactions within and between bacteria and fungi lineages change along chronosequence. Our results showed there was no significant pattern in network co-occurrence of the soil microbiota with increasing soil ages since retreating of the glacier, although the network of bacteria lineage became less connected along succession. On the contrary, our results suggested soil properties that are highly correlated to soil development were accountable for the alternation in network co-occurrence, while the accumulation of total organic carbon (TOC) and the decrease in soil pH weakened the network associations. We also found the ecological clusters which prefer high pH and low TOC played more important roles in the bacterial co-occurrence network. This study provided new evidences and perspectives for bacterial and fungal communities that may have divergent trajectories and driving forces in early glacier primary succession, as well as revealed the ecological importance of decreasing pH and increasing TOC in weakening the network co-occurrence.

Poster Presentation | P5 15

Changes in Meso-and Macro-zooplankton communities along the Northern Antarctic Peninsula (Summer 2019-2020)

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ABSTRACT

The Northern Antarctic Peninsula (NAP), located in the West Antarctic is amongst the most impacted regions by recent warming events. We saw extreme temperatures on land and sea in the Antarctic during 2019-2021. The ecological importance of these communities by their vulnerability to climate change has already led to an accumulation of severe changes along with its ecosystems and has attracted recent attention to the scientific community. Zooplankton respond more rapidly to environmental change than higher trophic level taxa Therefore, this work analyzed changes in meso- and macro- zooplankton community composition, as well as might be useful for discerning signs of environmental change. Samples were collected on board the oceanographic vessel BAP Carrasco at 21 stations inside the Bransfield Strait (BS) and around Elephant Island during summer 2019-2020. Meso-zooplankton was hauled using vertical tows with WP2 (200 µm) from at least 300 m and macro-zooplankton hauled using oblique tows with IKMT (500 µm) net from 170m to surface. Conductivity, temperature, and density (CTD) profiles were obtained with a SeaBird CTD, and analyzed from surface to 300 m. The waters in BS and around Elephant Island can be divided into relatively cool (T < 1 °C), saline (34.3 < S < 34.5 ups) homogeneous transitions waters, dominated by characteristic typical of the Wedell Sea at the southeastern of BS, and warm (0 °C < T), low salinity (S < 34.4 ups) and well stratified waters dominated by characteristic typical of the Bellingshausen Sea at the southeastern of the Shetland Island and around of Elephant Island (Upper Circumpolar Deep Water and Modified Circumpolar Deep Water). This water distribution showed that in general temperatures were high and it was related to the extreme temperatures registered during the 2019-2020 summer. A total of 118 morphospecies were found, 69 were collected with WP2, and 49 were collected with IKMT. Zooplankton abundance was especially higher around the stations at Elephant Island 29 ind/m3. The majority abundance was represented by Salpa thompsoni, small copepods, and adults and juveniles of Krill. Although Salpa thompsoni and small copepods were found in all study area. The copepods had two small dominant species, Oithona similis (43,86%) and Ctenocalanus citer (11%), follow by Salpa thompsoni (20.26%) and Euphasia superba adults and juvenile (7,81%) and Thysanoessa macrura (4.97%). We attribute the main changes in the community structure of the zooplankton to fluctuations in the abundance of copepods, salps, and krill promoted by the warm conditions on the NPA. During summer 2019-2020, the zooplankton showed that temperature and oxygen concentration from surface to 200m contributed to explaining the variability of the spatial distribution of zooplankton groups (ps: 0,594). Although is still uncertain how these stressors will shape biological communities along with the NAP, several responses have already been observed across multiple trophic levels. At the meso- and macro-zooplankton, repercussions include changes in composition and sizes of the species. Copepods changed by small species that is prey mainly on the microbial loop, as well as decline Antarctic Krill (E. superba) populations in favor of gelatinous (S. thompsoni). This scenery could be unsustainable for the high tropic levels, which depends on the quality and abundance of the low trophic levels.

Poster Presentation | P5 16

Prospect of HSP70 in Glaciozyma antarctica as biomarkers under climate change scenario

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ABSTRACT

Hsp70 are among the prominent stress proteins to be expressed following environmental insults, especially thermal stress. They are very useful to be used as biomarkers to monitor the impact of rising temperatures in Antarctica. This study describes the first detailed molecular characterization of the function and structure relationship of heat shock protein 70 (Hsp70) genes from an Antarctic marine yeast, Glaciozyma antarctica designated as GaHsp70-1 and GaHsp70-2. The full-length cDNA of GaHsp70-1 and GaHsp70-2 consist of 1815 bp and 2019 bp open reading frame, which encode proteins of 627 and 672 amino acids respectively. The main objectives of the present study are 1) to evaluate the Hsp70 gene expression responses to thermal stress in G. antarctica, 2) to characterise the Hsp70 functions in vitro and 3) to determine the relationship between the structures and functions of Hsp70s in G. antarctica. The gene expression of both Hsp70 are shown to express inducible patterns when cells are exposed to different temperatures ranging from -20°C to 30°C. ATPase assay revealed that G. antarctica Hsp70 can function at the range of 4°C to 37°C. Structural analysis shows a substitution of βsheet to loop at the ATPase domain and modest residue substitutions which possibly allow the proteins to function at temperatures far from the cell optimum temperature of 12°C. The use of Hsp70 from G. antarctica as a heat stress indicator caused by global warming on the polar environments as in the present study can be measured through the induction of Hsp70. This study represents Hsp70 as a good biomarker of thermal stress which since known heat stress alters gene expression in the cells of this yeast. Hence, the detection of Hsp70 in G. antarctica can constitute an early-warning marker for the effect of ocean warming at a sub-lethal level and potentially lethal damage.

Poster Presentation | P5 17

Polar Microalgae Project: understanding of species-specific ecophysiological responses to recent climate changes at the phenotypic and genetic levels

Sung Mi Cho

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ABSTRACT

Polar microalgae can be found in a wide range of ecological niches, including freshwater, snow surfaces, melting ponds, soil, and lichen symbiotic ecosystems, and are thus considered to be organisms that have successfully adapted to extremely cold environments. They play also predominant roles as a primary producer in micro-habitats which have quite variable ranges of environmental factors, temperature, light conditions, pH, and nutrients. The majority of polar microalgae thus are endemic and have developed to maximize their ability to fit on their microhabitats, yet their impact on species-specific eco-physiological responses to recent climate change was poorly understood. The goal of this study is to uncover the phenotypic and genetic responses of polar microalgae to environmental stress to better understand the effects of recent climate change on the polar micro-ecosystem. We chose the six species from each major clade based on phylogenetic analysis and physiological parameters such as growth assessment by temperature ranges (4 to 16 °C), the extent of lipid production, freezing-thawing resistance, and distinguishable morphological aspects (e.g. pigmentation, exopolysaccharide production, cell flocculation, and floating). We have optimized the whole genome pipeline to produce a highquality polar microalgal genome database. With the unique pipeline, we analyze two Micractinium genomes belonging to Chlorellaceae (Trebouxiophyceae) which were recently reported as novel species. These genome sizes are ~10% larger than those of the mesophilic alga M. conductrix and they contain several species-specific biosynthetic pathways. We introduce polar microalgae and their unique genetic features, species-specific adaptation mechanisms, and vulnerability to future climate changes in this presentation.

Poster Presentation | P5 18

Mare incognita: Adélie penguins foraging in newly exposed habitat after calving of the Nansen Ice Shelf

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ABSTRACT

Rapid environmental changes can dramatically and durably affect the animal's foraging behavior. In the Ross Sea (Antarctica), calving of the Nansen Ice Shelf in 2016 opened a newly accessible marine area of 214 km2. In this study, we examined the foraging behavior of Adélie penguins from the nearby Inexpressible Island in December 2018, by tracking 27 penguins during their atsea trips using GPS, depth and video loggers. The penguins mainly foraged within 88.2 ± 42.9 km of their colony, for 23.4 ± 6.8 h. Five penguins headed south to the newly exposed habitat along the Nansen Ice Shelf, whereas 22 penguins exploited previously available foraging areas. There was no significant difference in any of the foraging trip or diving parameters between the two penguin groups; however, in the calved region the penguins were diving into shallow areas more often than did the other penguins. These results show that Adélie penguins on Inexpressible Island had started to explore the newly exposed area within two years after calving. We conclude that the penguins respond to newly available habitat following stochastic environmental events, either through information sharing at the colony, and/or by balancing prey availability per capita across the foraging sites. Considering that this penguin breeding area is under investigation for the establishment of an Antarctic Specially Protected Area (ASPA), the results of this study may provide insights for evaluating the ecological importance of this area and formulating an ASPA management plan for conservation.

Poster Presentation | P5 19

Microbial community structure across the environmental gradients and physiological characteristics of culturable bacteria in the East Siberian Sea

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ABSTRACT

The rising temperature in the Arctic Ocean causes sea ice fluctuation, primary production, and riverine input in marine environment and these changes, in turn, have significant impacts on benthic ecosystems. To understand how these changes affect benthic ecosystem function, we firstly characterized the microbial diversity of marine sediments in the East Siberian Sea (ESS) shelf and slope and analyzed the relationship between environmental factors and microbial community composition. In addition, to understand the roles of bacteria in the benthic ecosystems, physiological characteristics of culturable bacteria such as response to temperature and degradation of macromolecules were investigated. Bacterial community were dominated by the phyla Proteobacteria (28.0±19.6%), Bacteroidetes (12.4±9.6%), Planctomycetes (10.1±5.1%) and Acidobacteria (7.5±5.0%) across the site. The composition of archaeal community was dominated by the phyla Thaumarchaeota (83.5±22.6%) and Bathyarchaeota (8.0±15.5%). Microbial community composition was clearly differentiated into two groups according to the salinity (35 psu) which is related with the distance from the land. Fifty bacterial isolates were obtained and assigned into 15 phylotypes of the phyla Actinobacteria (2), Bacteroidetes (26), and Firmicutes (2), and classes Alphaproteobacteria (14), Betaproteobacteria(1), and Gammaproteobacteria (5). Most of the isolatesgrew well between 4 C and 15 C. As the temperature increased to 20 C, 25 C, and 30 C, the number of isolates can grow were decreased. Of these, 28 strains produced at least one type of extracellular amylase, protease, polymer and 13 strains were able to hydrolyze hypoxanthine implying that bacterial taxa contribute to nutrient cycling by the hydrolysis of major organic compounds. As the first report on the microbial structure in the ESS, this study provides a fundamental insight on microbial diversity and their putative ecological functions in the ESS that is dynamically affected by global warming.

Poster Presentation | P5 20

Dietary niche partitioning in Brown skuas (Stercorarius lonnbergi) during the chick-rearing period at Narębski Point on King George Island, Antarctica

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ABSTRACT

Brown skuas (Stercorarius lonnbergi) are known to feed on other birds or eggs during the breeding season. In some cases, however, a few pairs monopolize a penguin colony, and the other skuas mainly forage in the sea. We installed automatic camera traps to monitor two groups of breeding brown skua pairs on King George Island: the nests of group A were located near the Gentoo penguin colony, while those of group B were relatively far away. From the resulting photographs, we were able to distinguish the food items that parents brought to the nest and could confirm the egg hatching date. Overall, 97.1% of the food items that group A brought to the nest were from the penguin colonies, while 94.1% of the prey items of group B were fish. Group A had a hatching date at least 8 days earlier than group B. Our results show that a few brown skua pairs that bred near the penguin colony fed primarily on penguin nests within their feeding territory and had earlier hatching dates. The brown skuas that nested close to penguin nests may have had advantages in foraging and breeding performance.

Poster Presentation | P5 21

Investigation of intertidal macroalgal distribution and biomass using UAV in Barton Peninsula, King George Island, Antarctica

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ABSTRACT

Antarctica is where the effects of global warming are most severe. Glaciers are rapidly retreating due to recent climate change, and this impact could increase the habitat availability of Antarctic intertidal assemblages. Research on macroalgae in Antarctica has been carried out in various ways, but a few quantitative studies have been carried out in the intertidal zone. In this study, we tried to investigate the distribution and biomass of macroalgal assemblage using UAV (Unmanned Aerial Vehicle) and random quadrat methods in the Antarctic intertidal zone. Sampling was performed in January 2020 by automated photographing a 9,600 m2 intertidal zone in the southern coast of the Barton Peninsula with a small drone at the highest low tide time. In order to estimate the biomass using the relationship between the biomass and the coverage, the coverage and biomass of each species were measured in 21 randomly arranged quadrats. Total of 18 (2 green, 5 brown and 11 red) species have been recorded, despite the low species diversity, and the biomass was 2,017 ± 92 g m-2 wet weight (mean ± S.E.) and a maximum of 7,350 g m-2 wet weight. The dominant species based on biomass were Phaeurus antarcticus and Iridaea cordata, and their relative biomass was 45.7% and 41.3%, respectively. Also, the proportion of biomass of 5 species out of the total 17 species reached 94.5%. Since the biomass estimated by the relationship of coverage-biomass was 97.9% of the measured biomass. The creation of new habitats due to glacial retreat and increase of temperature may expand some of the distribution of macroalgae in the Antarctic intertidal zone. Therefore, this study will be used as base-line to understand the changes in the Antarctic intertidal macroalgal assemblage in the future.

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