The 20th International Symposium on Polar Sciences

Our Collective Journey to Connect the Past and Future from the Antarctic

May 27 - 29, 2014
Korea Polar Research Institute
Incheon, Republic of Korea

Organized by
Korea Polar Research Institute

Symposium Program at a Glance

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Symposium Program

May 27 (Tuesday)		
09:00 - 09:50	***Registration & Coffee Break***	
Opening Ceremony & History and Outlook of the Korean Antarctic Program		*Auditorium*
10:00 - 10:10	***Welcome Address***	
10:10 - 10:30	***History and Outlook of the Korean Antarctic Program***	
Plenary Lecture		*Auditorium*
10:30 - 11:10	**Lonnie Thompson**	***Global Climate Change: A Paleoclimate Perspective from the Polar Regions to the World's Highest Mountains***
11:15 - 11:25	***Group Photo***	
11:30 - 13:00	***Lunch & Poster Session***	
Plenary Lecture		*Auditorium*
13:00 - 13:40	**John Turner**	***Antarctic Climate Change Over the Last 50 Years and Predictions for the Next Century***
Parallel Sessions	**Antarctic Climate Records: Late Quaternary Ice Core and Geological Records** *Auditorium*	**Life of King George Island in the Changing Environment** *Seminar Room*
14:00 - 14:20	**Eugene DOMACK** ***Recent Analogs for Snowball Earth Sediments and Stratigraphy Discovered Beneath Antarctic Ice Shelves: Changing Paradigms and the Origin of Metazoans***	**In-Young AHN** ***Coastal Marine Monitoring at the King Sejong Station, King George Island (KGI), Antarctica***
14:20 - 14:40	**Yeong Bae SEONG** ***Two Sisters Tell the Same Experience: A Tale from Larsen-B and C, Antarctica***	**Nobuo KOKUBUN** ***Study on Foraging Habitat of Penguins by Bio-Logging Approaches: Toward the Monitoring of Antarctic Coastal Ecosystem***
14:40 - 15:00	**Jinwook KIM** ***Antarctic Climate Record in Illite Crystallinity and Crystal Size Distribution***	**Javier ARATA** ***The Chilean Antarctic Program: Projecting into Uncharted Waters***
15:00 - 15:20	**Amy LEVENTER** ***Polar Marine Diatoms: Extending Their Use as Paleoenvironmental Proxies in the Antarctic Peninsula***	**Sanghee KIM** ***Establishing a Model Organism for Polar Research***
15:30 - 16:00	***Coffee Break & Poster Session***	

Parallel Sessions	The Amundsen Sea as a Window to View the Future of the Antarctic in a Changing Global Climate *Auditorium*	Interactions between the Solid Earth, the Oceans and the Cryosphere in the Victoria Land-Ross Sea, Antarctica *Seminar Room*
16:00 - 16:20	**Randolph WATTS** ***Cross-Frontal Fluxes in the ACC Near Udintsev Fracture Zone***	**Donald BLANKENSHIP** ***Airborne Studies of Subglacial Boundary Conditions in West Antarctica***
16:20 - 16:40	**Jae Hak LEE** ***The Udintsev Fracture Zone Experiment: A Study for Poleward Heat Flux and ACC Variability***	**Ki-Weon SEO** ***Long Term (1979-2012) Ice Mass Loss Acceleration in Antarctica***
16:40 - 17:00	**Hyoung Sul LA** ***Seasonal Variability of Biological Sound Scattering Layers in the Amundsen Sea, Antarctica***	**Christina HULBE** ***Measure for Measure: Using Models to Synthesize Heterogenous Observations of Change in West Antarctica***
17:00 - 17:20	**Sophie FIELDING** ***Observing Variability in Antarctic Krill Distribution in the Southern Ocean: From Discovery Days to Autonomous Vehicles***	**Ryan WALKER** ***Ocean Forcing of Ice-Sheet Margins: Thermodynamics and Tidal Effects***
17:20 - 17:40	**Tae-Siek RHEE** ***Recent Observations of Greenhouse Gases in the Pacific Sector of the Southern Ocean Onboard R/V Araon***	**Haru MATSUMOTO** ***Antarctic's Siren Call: The Sound of Icebergs***
17:40 - 18:00	**Sang Heon LEE** ***High Protein Incorporation of Phytoplankton in the Amundsen Sea***	**Paul EVENSON** ***Antarctica and the Global Neutron Monitor Network***

May 28 (Wednesday)

Plenary Lecture		*Auditorium*
09:00 - 09:40	**Douglas WIENS**	***Seismological Constraints on Solid Earth-Ice Sheet Interactions in Antarctica***

Parallel Sessions	The Amundsen Sea as a Window to View the Future of the Antarctic in a Changing Global Climate *Seminar Room*	Interactions between the Solid Earth, the Oceans and the Cryosphere in the Victoria Land-Ross Sea, Antarctica *Auditorium*
10:00 - 10:20	**Anna WÅ HLIN** ***Resonant Rossby Waves on the Outer Continental Shelf in the Amundsen Sea***	**Fred DAVEY** ***The Structure and Evolution of the Ross Sea***
10:20 - 10:40	**Pierre DUTRIEUX** ***Strong Sensitivity of Pine Island Ice-Shelf Melting to Climatic Variability***	**Yongcheol PARK** ***P-Wave Velocity Structure Beneath Mt. Melbourne in Northern Victoria Land, Antarctica: Deep LVZ and Its Shape***

10:40 - 11:00	**Karen ASSMANN** ***Circumpolar Deep Water Transport in the Amundsen Sea: The Representation of Antarctic Shelf Water Masses in the CMIP5 Models and Implications for the Mass Balance of the Antarctic Ice Sheet***	**Robert DZIAK** ***Sources of Long-Term Ambient Ocean Sound Near the Antarctic Peninsula***
11:00 - 11:20	**Travis MILES** ***Glider Observations Along the Dotson Ice Shelf***	**Masaki KANAO** ***Characteristic Cryoseismic and Oceanic Waves Associated with Surface Environments at the Lützow-Holm Bay, East Antarctica***
11:30 - 13:00	***Lunch & Poster Session*** ***(Korean Early Career Scientists Gathering)***	
Plenary Lecture		*Auditorium*
13:00 - 13:40	**Oscar SCHOFIELD**	***Glider Observations of Water Masses in the Amundsen Sea***
13:50 - 14:30	**John PRISCU**	***The McMurdo Dry Valleys Long-Term Ecological Research Project: Twenty One Years of Research Addressing Ecosystem Processes in a Changing Climate***
14:30 - 15:30	***Coffee Break & Poster Session***	
Parallel Sessions	**Antarctic Climate Records: Late Quaternary Ice Core and Geological Records** *Seminar Room*	**Life of King George Island in the Changing Environment** *Auditorium*
15:50 - 16:10	**Min Kyung LEE** ***Late Holocene Paleoclimatic Record Of Sediment Near Joinville Island: Preliminary Results***	**Ok-sun KIM** ***Exploring Microbial Diversity in Antarctic Terrestrial Ecosystems***
16:10 - 16:30	**Julia WELLNER** ***Sediment Grain Size, Shape, and Texture of the Perseverance Drift, Antarctic Peninsula: Transport History and Implications***	**Stephen CARY** ***Some Like it Hot: Global-Scale Microbial Dispersal Revealed in the Fumarolic Soils of Tramway Ridge, Mt Erebus, Victoria Land***
16:30 - 16:50	**Brad ROSENHEIM** ***Ramped Pyrolysis 14C Dating of Sediments: Case Studies and Progress from Antarctic Sediments***	**Kyung Mo KIM** ***Bioinformatics Studies for Analyzing NGS-Based Microbial Diversity Data***
16:50 - 17:10	**Robert McKAY** ***Early Holocene Retreat of the Marine-Based Ice Sheet in the Central Ross Sea***	**Leopoldo SANCHO** ***Biodiversity and Productivity of Lichens Along a Latitudinal Gradient from Transantarctic Mountains to Tierra Del Fuego***
17:10 - 17:30	**Richard LEVY** ***Connecting Holocene Climate Variability in Antarctica to the Mid Latitudes Via a New High Resolution Record from Lake Ohau, South Island, New Zealand***	**Hyoung Suk LEE** ***Molecular Responses of the Antarctic Vascular Plant Deschampsia Antarctica to Environmental Changes***
18:00 - 20:00	***Banquet***	

Symposium Poster Session

May 27-28 (Tuesday-Wednesday)

Antarctic Climate Records: Late Quaternary Ice Core and Geological Records (PS-C00)

PS-C01	Kitae KIM	*Dissolution of Iron and Manganese Oxides in Ice and its Impacts on Polar Regions*
PS-C02	Kitae KIM	*Enhanced Production of Atmospheric Iodine in Antarctica*
PS-C03	Eun Jung CHOY	*Spatial Variations of Primary, New and Regenerated Production After the Collapse of the Larsen Ice Shelf, Antarctica*
PS-C04	Jinhwa SHIN	*Millennial Atmospheric CO_2 Change During the Early Holocene*
PS-C05	Jihun KIM	*Holocene Paleoclimate Change in the Adélie Basin, East Antarctica (IODP Exp. 318 Site U1357)*
PS-C06	Kyeongsuk CHANG	*A 50-Year Record of Lead Isotopes in Antarctic Snow from Dome Fuji, East Antarctica*
PS-C07	Hun-Gyu LEE	*Atmospheric CO_2 Concentration Change During the Last Glacial Termination*
PS-C08	Jong Ku GAL	*Reconstruction of Paleo Sea Surface Temperature in Antarctic Sediments: Application of New Potential Proxy (OH-TEX86)*
PS-C09	Seong Joon JUN	*Design, Performance Tests and Application of Meltering System to Decontaminate Shallow Firn Cores*
PS-C10	Chung Yeon HWANG	*Prokaryotic Community Structure and Diversity an a Sediment Core of the Larsen C Area in the Weddel Sea*
PS-C11	Kyu-Cheul YOO	*Spectral Analysis of Cyclostratigraphy in the Holocene Glaciogenic Rhythmites, Larsen C Embayment, West Antarctica*
PS-C12	Kyu-Cheul YOO	*Hydrography of Marian Cove, King George Island, West Antarctica: Implications for Ice-Proximal Sedimentation During Austral Summer*

The Amundsen Sea as a Window to View the Future of the Antarctic in a Changing Global Climate (PS-A00)

PS-A01	Bo Kyung KIM	*Biochemical Compositions of Particulate Organic Matter in the Amundsen Sea, Antarctic*
PS-A02	Min-jee KIM	*RELOCATED TO PS-R16*
PS-A03	Minkyoung KIM	*Particulate Organic Carbon Cycling on the Amundsen Shelf*
PS-A04	Miseon KIM	*Estimation of POC Export Fluxes Using 234Th/238U Disequilibria in the Amundsen Sea, Antarctica: Preliminary Result*
PS-A05	Sun-Yong HA	*Spatial Distribution of Mycosporine-Like Amino Acids in the Southern Ocean - Curize of RV Polarstern (ANT XXVI/2)*
PS-A06	Tae-Wan KIM	*Effects of Wind and Sea Ice on the Seasonal Variation of Warm Circumpolar Deep Water in the Amundsen Sea*
PS-A07	Seung Kyeom LEE	*Variability in Satellite-Driven Chlorophyll Associated with El Niño - Southern Oscillation in the Southern Ocean*

PS-A08	Intae KIM	*Significant Influence of Glacier Melting on the Level of Trace Elements in Coastal Seawater Off Antarctica*
PS-A09	Eurico D'SA	*Satellite-Derived Optical Absorption Properties in the New Zealand Sector of the Southern Ocean During Austral Summer of 2014*
PS-A10	Jung-Ho HYUN	*Heterotrohic Bacterial Biomasss and Production During Late Phytoplankton Bloom in the Amundsen Sea Polynya, Antarctica*
PS-A11	Yong JIANG	*Spatial Patterns in Pelagic Ciliate Community Responses to Various Habitats in the Amundsen Sea (Antarctica)*
PS-A12	Ayeon CHOI	*Diversity and Abundance of Functional Genes Associated with Denitrification and Anaerobic Ammonium Oxidation in the Sediment of the Amundsen Sea Polynya, Antarctica*
PS-A13	Sung-Han KIM	*Rates of Benthic Respiration and Nutrient Flux at the Sediment-Water Interface in the Polynya of the Amundgen Sea, Antarctica*
PS-A14	Doshik HAHM	*Spatial and Temporal Variation of Net Community Production in the Pacific Sector of the Southern Ocean*
PS-A15	Jai-Ho OH	*Analysis of Future Sea Ice Variability and TRENDs over Antarctic in 21st century based on IPCC climate change scenarios*
Interactions Between the Solid Earth, the Oceans and the Cryosphere in the Victoria Land-Ross Sea, Antarctica (PS-V00)		
PS-V01	Masaki KANAO	*Characteristic Atmosphere and Ocean Interactions in the Coastal and Marine Environment Inferred from Infrasound Arrays at Lützow-Holm Bay, East Antarctica*
PS-V02	Boo-Keun KHIM	*Recent and Past Sedimentary Dynamics on Slope Area of the Ross Sea: Preliminary Data*
PS-V03	Sookwan KIM	*Paleo Depositional Environment in the Outer Shelf and Slope of the Central Basin, Ross Sea, Antarctica from Seismic Stratigraphy and Tomography*
PS-V04	Seung Goo KANG	*2D Acosutic-Elastic Coupled Waveform Inversion in the Laplace Domain Using Gradient Scaling Method*
PS-V05	Jong Jin LEE	*Geochemical Change of Core KI-13-C1 in the Central Basin of the Ross Sea (Antarctica)*
PS-V06	Hoje KWAK	*High-Resolution Seasonal Variations of Chemical Compositions in Recent Snow on Styx Glacier Plateau, Victoria Land, Antarctica*
PS-V07	Choon-Ki LEE	*Changes in the Drygalski Ice Tongue, Antarctica Observed from Continuous GPS Measurements*
PS-V08	Yun Seok YANG	*Preliminary Studies on Melt Inclusions and Volatile Analysis in Basalts Recovered from Australian-Antarctic Ridge*
PS-V09	Hakkyum CHOI	*Bathymetric and Magnetic Characteristics of the Easternmost Segment of Australian-Antarctic Ridge, 156°-161°E*
PS-V10	Won Sang LEE	*Variability of Double Frequency Microseisms and Sea Ice in the Ross Sea, Antarctica*
PS-V11	Won Sang LEE	*Integrated Cryosphere Monitoring Network in the Victoria Land-Ross Sea, Antarctica*
PS-V12	Sukyoung YUN	*Deployment of Ocean Bottom Seismometers in the Ross Sea, Antarctica*

Life of King George Island in the Changing Environment (PS-K00)		
PS-K01	Jaewoo JUNG	*Structural and Chemical Modification of Fe-rich smectite Associated with Microbial Fe-Respiration in King George Island, West Antarctica*
PS-K02	Ahnna CHO	*Comprehensive Survey of Soil Bacterial Community Structure in Barton and Weaver Peninsula of King George Island, Antarctica*
PS-K03	Miye KWON	*Comprehensive Analysis on Bacterial Biodiversity in Ice-Covered Antarctic Lakes of McMurdo Dry Valleys*
PS-K04	Gi Young JEONG	*Rock Weathering of Volcanics by Lichen in the Maritime Antarctic*
PS-K05	Misa JEON	*Temporal Variation of Microalgae and Environmental Factors in the Surface Water of Marian Cove, King George Island, Antarctica, 2010*
PS-K06	Sojin KIM	*Lobarstin Enhances Chemosensitivity in Human Glioblastoma T98G Cells*
PS-K07	Sungsin JO	*Lobarstin Induces Cell Death in Acute Promylocytic Leukemia NB4 Cells*
PS-K08	Chung Yeon HWANG	*High-Quality Draft Genome of Alphaproteobacterial Strain PAMC 27157, the First Representative of a New Genus in the Family Aurantimonadaceae*
PS-K09	Eun Jae KIM	*Production of an Ice Binding Protein from Flavobacterium frigoris PS1 by Fermentaion of Pichia pastoris*
PS-K10	Yung Mi LEE	*Lacinutrix jangbogoensis, sp. nov., A Psychrophilic Bacterium Isolated from Marine Sediment of Antarctic*
PS-K11	Hyun-Ju NOH	*Microclimate Monitoring Around Lichen Habitat in Barton Peninsular, King George Island, Antarctica*
PS-K12	You-Jung JUNG	*Physiological Characteristics of Polar and Alpine Bacteria According to the Taxonomy, Habitat, and Geographical Origin*
PS-K13	Yung Mi LEE	*Polar and Alpine Microbial Collection (PAMC): a Culture Collection Dedicated to Polar and Alpine Microorganisms*
PS-K14	Hye-Won MOON	*Impacts of Glacier Retreat on Nearshore Marine Benthic Communities in a Glacial Embayment, King George Island, Antarctica*
PS-K15	Yoonjee KANG	*Isolation of a Low Temperature-Regulated CBF/DREB-Like Gene from Deschampsia antarctica Desv. and Development of Stress-Tolerant Rices*
PS-K16	Kiwoon BAEK	*Psychroserpens marinus sp. nov., Isolation from Seawater*
PS-K17	Seok Cheol KIM	*Spatial Patterns of Terrestrial Vegetation at Multiple Spatial Scales in Barton Peninsular of King George Island Located in the Maritime Antarctic*
PS-K18	Sook-Young LEE	*Analysis of Complete Genome Sequence of Adenovirus Detected from South Polar Skua (Catharacta maccormicki) in Antarctica*
PS-K19	Sook-Young LEE	*Genetic Analysis of a Novel Adenovirus Detected from Chinstrap Penguins (Pygoscelis antarctica) in Antarctica*
PS-K20	Seong-Geun JEONG	*The Formation of Biofilm by Antarctic Marine Bacteria in a Microfluidic Device with a Temperature Gradient*
PS-K21	Chaeyeon KIM	*Development of Droplet Merging System in Microfluidic Device for Biological Reactions*

PS-K22	Sun-Mi KIM	*Morphology, DNA Barcoding and Phylogenetic Relationships of the Bangiales (Rhodophyta) from King George Island, the Antarctic and its Adjacent Waters*
PS-K23	Young-Jun YOON	*Moss Flora of King George Island*
PS-K24	Jaeeun SO	*Morphological Characteristics of the Cladonia chlorophaea Group*
PS-K25	Mun Gi KIM	*Distinctive environmental control on stable carbon isotope composition of vegetation growing in high-latitudes*
Arctic And Other Related (PS-R00)		
PS-R01	Yongwon KIM	*Effect of Precipitation On CO_2 Efflux from Tundra Lichen, Moss, and Tussock, Council, Alaska*
PS-R02	Mi Sun YUN	*Macromolecular Compositions of Phytoplankton and Proximate Compositions of Mesozooplankton in the Northern Chukchi Sea*
PS-R03	Young-Gyun KIM	*Intermittent Expulsion of Warm Methane Fluid from Mud Volcano in the Canadian Beaufort Sea*
PS-R04	Kwan Woo KIM	*Latitudinal Variation of Phytopalntkon Production in Melt Ponds, Arctic*
PS-R05	Jin Hoi HWANG	*The Idea of Practical Strategies Regarding Polar Oceans: By Analyzing Policies of Major Countries and International Institutes*
PS-R06	Mi Ok KWON	*Numerical Experiment of Tidal Effect on the Arctic Ocean Using an Ice-Coupled Ocean Model*
PS-R07	Jung Ok PARK	*A Metagenetic Approach to the Small Soil Metazoan Community of Svalbard: Local and Geographical Patterns of Variation in Community Structure*
PS-R08	Renat SHAKIROV	*Gas-Geochemical Features of Sediments in the East-Siberian and Chukchi Seas (Eastern Arctic)*
PS-R09	Hyoung Sul LA	*Warm Eddy Effects on the Distribution of Arctic Mesozooplankton in the Western Arctic Ocean*
PS-R10	Sun-Yong HA	*Distribution of Mycosporine-Like Amino Acids Along Size-Fractionated Phytoplankton in the Bueafort Sea, Arctic*
PS-R11	Ji-Woong YANG	*Greenhouse Gas Anomalies Observed from Tsambagarav (Mongolian Altai) Ice Core*
PS-R12	Jeong Soo PARK	*Analysis of Environmental Factors Determining Distribution of Arctic Vegetation in Svalbard*
PS-R13	Eunji BYUN	*CO_2 and CH_4 Depth Profiles from Alaskan Soil Cores: Headspace Gas Analysis for Trapped Greenhouse Gases in Soil*
PS-R14	Hackwon DO	*Structure-Based Characterization and Antifreeze Properties of a Hyperactive Ice-Binding Protein from the Antarctic bacterium Flavobacterium frigoris PS1*
PS-R15	Do Hwan AHN	*Characterization of Toll-Like Receptor Family Genes of the Notothenia coriiceps and Molecular Responses to Pathogen Agonist*
PS-R16	Min-jee KIM	*Vertical Distributions on Biochemical Composition of Particulate Organic Matter*

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PLENARY LECTURE

GLOBAL CLIMATE CHANGE: A PALEOCLIMATE PERSPECTIVE FROM THE POLAR REGIONS TO THE WORLD'S HIGHEST MOUNTAINS

Lonnie G. Thompson

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ABSTRACT

Glaciers serve both as recorders and early indicators of climate change. Over the past 35 years our research team at the Byrd Polar Research Center has recovered climatic and environmental histories from ice cores drilled in both Polar Regions and from low to mid-latitude, high-elevation ice fields. These ice core –derived proxy records, many of which extend back over 25,000 years, have made it possible to compare glacial stage conditions in the tropics with those in the polar regions, as well as more detailed events over the last 10,000 years. In 2010 we recovered a 448-meter core to bedrock from the Bruce Plateau as part of the LARISSA project. This and other high-resolution records of stable isotopes (in part a temperature proxy) from the Antarctic Peninsula demonstrate regional climatic variability that is also observed in records from high elevations in the mid-to lower latitudes. However, most climate records from lower latitudes, when taken together, show current warming that is unprecedented for the last two millennia. Indeed at many alpine sites the current warming is unprecedented since the early Holocene. It is possible to relate abrupt changes in climate over the Holocene, which may have had effects on human health and history, to climate phenomena such as the El Niño-Southern Oscillation (ENSO). The environmental archives from Antarctic and tropical ice cores will be explored to demonstrate how global "Black Swan" events have been recorded in the Earth's cryosphere. Ice cores retrieved from shrinking glaciers confirm their continuous existence for periods ranging from hundreds to thousands of years, suggesting that current climatological conditions in those regions are different from those under which these ice fields originated and have been sustained. The ongoing widespread melting of high-elevation glaciers and ice caps, from the Antarctic Peninsula to low/middle latitudes, provides strong evidence that a large-scale, pervasive and, in some cases, rapid change in Earth's climate system is underway. The history of these ice caps, told through the scientific evidence gained under often challenging conditions from some of world's most remote regions, provide a global perspective for contemporary climate.

ANTARCTIC CLIMATE CHANGE OVER THE LAST 50 YEARS AND PREDICTIONS FOR THE NEXT CENTURY

John Turner

British Antarctic Survey

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ABSTRACT

In recent decades Antarctica has experienced a complex picture of climate change, with the Antarctic Peninsula and parts of West Antarctica having warmed as much as anywhere on Earth, but with much of East Antarctic having had little change in near-surface temperature. A key feature driving change in West Antarctica is the Amundsen Sea Low (ASL), which is the climatological area of low pressure to the west of the Antarctic Peninsula. Since 1979 the ASL has deepened, but the reasons for this are unclear as the low is strongly influenced by a number of factors, including tropical climate variability, the loss of stratospheric ozone and also experiences a large intrinsic variability. However, the deepening of the ASL has resulted in a dipole of change in the sea ice extent, with ice loss in the Bellingshausen Sea and an increase across the Ross Sea. In contrast to the Arctic, sea ice around the Antarctic has increased at a statistically significant rate. A major factor in recent Antarctic climate change has been the loss of stratospheric ozone. This has increased the strength of the westerly winds over the Southern Ocean and been largely responsible for the summer/autumn warming on the Antarctic Peninsula and played a part in the collapse of a number of the ice shelves. However, the ozone hole only developed around 1980 so its impact is superimposed on longer term change. Over the next century the ozone hole is expected to recover, but it is likely that greenhouse gas concentrations will increase. For a medium greenhouse gas emission scenario it is expected that Southern Ocean sea ice will be reduced by about one third, and that surface temperatures across the continent will increase by 3-4 degrees C.

SEISMOLOGICAL CONSTRAINTS ON SOLID EARTH-ICE SHEET INTERACTIONS IN ANTARCTICA

Douglas A. Wiens

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ABSTRACT

Recent broadband seismograph deployments are greatly increasing the seismic coverage of Antarctica and leading to the development of new higher resolution seismic models of the continent, which is poorly understood due to limited geological exposure. The new results reveal that East Antarctica represents an ancient continent, with a probable average geological age of early Proterozoic and with highlands supported by thick continental crust. Mountain building in East Antarctic likely occurred through compressional orogenesis no later than early Paleozoic, with high elevations maintained by low erosion rates. Thus East Antarctic highlands such as the Gamburtsev Subglacial mountains served as the nucleation zones for ice sheet development throughout much of the Phanerozoic.

We use seismic velocity maps to constrain parameters important for ice sheet models such as heat flow and mantle viscosity. Inferred mantle viscosity is lowest beneath Marie Byrd Land and highest beneath East Antarctica, and the variation is large enough to have a first order effect on glacial isostatic adjustment (GIA). Inferred mantle viscosity in West Antarctica is much lower than used in recent GIA models, and limits the GIA response to ice sheet mass changes to the last several hundred years. The Transantarctic Mountains lie along a first order boundary in mantle viscosity, probably leading to a complicated GIA response poorly modeled by 1-D viscosity models. West Antarctica shows low mantle seismic velocities associated with late Cenozoic rift systems and with a large mantle thermal anomaly supporting the Marie Byrd Land dome. These structures suggest high geothermal heat flow may have a first order effect on glacial dynamics in West Antarctica, as indicated by recent high heat flow measurements from the WAIS ice core. In addition, the recent discovery of an active subglacial volcano near Mt Sidley suggests episodic subglacial eruptions may have an important effect on the ice sheet.

Seismic data also provides important constraints on the movement and dynamics of ice sheets. We use co-located seismographs and GPS receivers deployed on the Whillans Ice Stream to obtain very broadband records of ice velocity during the twice-daily stick-slip events. These records, combined with observations of far-field Rayleigh waves, reveal that the stick-slip motion is controlled by high friction regions located along the grounding line.

GLIDER OBSERVATIONS OF WATER MASSES IN THE AMUNDSEN SEA

Oscar Schofield, Chip Haldeman, Travis Miles*

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ABSTRACT

During ship-based expeditions in the austral summer seasons in 2011/2012 and 2013/2014 we deployed Teledyne Webb gliders in the Amundsen sea. During the 2011/2012 season, two shallow glider missions mapped the areas near the ice edge spanning 375 kilometers over a 15 day period. In agreement with the sparser ship surveys, chlorophyll fluorescence and optical backscatter were enhanced in warmer and lower salinity surface waters. Beyond the variability in the phytoplankton/particle concentrations, the optical proxies suggest a shift in the nature of the particles. Discrete data collected by the ship confirmed the changing concentration and nature of the material in the low salinity plumes. During the 2013/2014 expedition, two gliders (one shallow and deep water class vehicle) were deployed. The shallow and deep-water gliders both confirmed that warm and low salinity waters were characterized by high phytoplankton and particle concentrations. Fast repetition rate fluorometry indicate higher quantum yields in the high biomass waters. The deep-water glider captured the bottom water flow of warm water under the ice shelf and quiescent off-ice shelf flow elsewhere along the shelf. The return flow suggested a decrease in the bottom water temperature. These deployments demonstrate the utility of gliders in surveying and characterizing remote locations in the Amundsen sea. Discussion will focus on potential flight patterns that might allow for optimal flight strategies to allow ship time to be heavily focused on experimental manipulations.

THE MCMURDO DRY VALLEYS LONG-TERM ECOLOGICAL RESEARCH PROJECT: TWENTY ONE YEARS OF RESEARCH ADDRESSING ECOSYSTEM PROCESSES IN A CHANGING CLIMATE

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ABSTRACT

The McMurdo Dry Valleys Long-Term Ecological Research (MCM LTER) Program is an interdisciplinary and multidisciplinary study of the aquatic and terrestrial ecosystems in an ice-free region of Antarctica. MCM joined the National Science Foundation's LTER Network in 1993 and is funded through the Office of Polar Programs in six year funding periods. The McMurdo Dry Valleys (77°30'S 163°00'E) on the shore of McMurdo Sound, 3,500 km due south of New Zealand, form the largest relatively ice-free area (~4,800 km^2) on the Antarctic continent. These ice-free areas of Antarctica display a sharp contrast to most other ecosystems in the world, which exist under far more moderate environmental conditions. The perennially ice-covered lakes, ephemeral streams and extensive areas of exposed soil within the McMurdo Dry Valleys are subject to low temperatures, limited precipitation and salt accumulation. The dry valleys represent a region where life approaches its environmental limits, and is an end-member in the spectrum of environments included in the LTER Network. Research themes for the past four funding cycles of the MCM LTER have focused on (i) the physical constraints controlling the structure and function of the ecosystem, (ii) the legacy of past climate on contemporary ecosystem structure and function, (iii) the role of climate legacies on contemporary biodiversity and ecosystem function, and (iv) increased landscape connectivity in a polar desert resulting from present day climate warming. Significant result from each of these funding cycles will be presented and discussed in terms of our present understanding of the MCM LTER.

SESSION

Antarctic Climate Records: Late Quaternary Ice Core and Geological Records

RECENT ANALOGS FOR SNOWBALL EARTH SEDIMENTS AND STRATIGRAPHY DISCOVERED BENEATH ANTARCTIC ICE SHELVES: CHANGING PARADIGMS AND THE ORIGIN OF METAZOANS

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ABSTRACT

Despite nearly 50 years of intense scientific investigation since the IGY vast areas of the Antarctic continental margin remain unexamined and this is particularly so for regions beneath ice shelves and ice sheets. As new areas open up for scientific exploration, due to advanced technology and/or climatically induced ice shelf collapse, newly examined deposystems are providing useful facies context for ancient strata, including those of Neoproterozoic age (i.e. Cryogenian to Ediacaran). While the Snowball Earth hypothesis rests on the agreement of a diverse set of geochemical, sedimentologic, and geochronology data sets, acceptance of the concept has been challenged based upon sedimentologic arguments—arguments which utilize general assumptions about: ice rafting, facies succession, biota, and glacial thermal regime. Detailed examples based upon sub ice shelf sediments from Antarctica are used to demonstrate that general principles, employed by some investigators to detract from a coherent interpretation of Cryogenian strata, are invalid and in need of revision. Furthermore, specific facies context for Neoproterozoic successions in East Greenland, Svalbard, Namibia, and Australia are used to exemplify how new discoveries made in Antarctica can provide more realistic interpretations of such ancient strata. Further, by documenting the change in physical process and associated biota---- hypotheses for the evolutionary step to metazoan life (observed after the Marinoan snowball event at about 630 Ma) are better informed. The Antarctic realm is the best analogy we have for conditions proposed to be in existence in an ice bound earth, and we are just beginning to uncover the hidden worlds beneath the ice and the light they can shed into deep time.

TWO SISTERS TELL THE SAME EXPERIENCE: A TALE FROM LARSEN-B AND C, ANTARCTICA

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ABSTRACT

The recent collapse of Larsen B ice shelf (LIS-B) has attracted a lot of attentions, particularly on the feedback on the sea level rising in relation to global warming and the stability of Larsen ice shelves during the Holocene has been independently studied, suggesting that Larsen ice shelf A and B experienced different histories. LIS-B was stable throughout the Holocene until its recent collapse based on records of diatoms in marine sediment cores (Domack et al., 2005), while LIS-A was substantially collapsed during the middle to late Holocene, and then newly re-formed (Balco et al., 2013). We had the luck to retrieve geologic evidences from on land as well as the sea off the Larsen Ice Shelf during the Araon Cruise of 2012-13 Austral summer. Meteoric ^{10}Be abundances were analyzed on the core sediments from LIS-B and-C, respectively. Meteoric ^{10}Be, one sister of cosmogenic nuclides family, is mostly produced in the stratosphere and quickly falls out to the surface of the ocean and the land. The rate of input of meteoric ^{10}Be to the ocean has been constant over long-term (up to 12 my) scale, dampened by ice and snow cover in the Antarctic sea. In particular, covering of sea ice or glacier decreases the abundances of ^{10}Be in the authigenic sediments. Our meteoric ^{10}Be results from the sediments cores from LIS-B and C show the systematic change with the degree of openness of surface ocean, mainly caused by growth and decay of ice shelf, telling that the region experienced four distinct stages of deglacial history such as glacial (under the grounding zone), deglacial (in the front of grounding zone), sub-floating ice shelf, and open marine. Concentration of meteoric ^{10}Be from the top-most sediments deposited under open ocean (~10^9 atoms per gram of sediments) is 3 orders of magnitude greater than the one of lower-most sediments deposited under grounding zone (~10^6 atoms per gram of sediments). Our interpretation using meteoric ^{10}Be is consistent with the reconstruction of deglacial history based on sedimentary facies and other fossil and chemical index. What is most clear from our meteoric ^{10}Be data is that there is only one sharp increase in concentration of ^{10}Be, implying that the ice shelves (LIS-B anc C) experienced only one event of large collapse during the deglacial (roughly Holocene) period which is very similar to LIS-A marine record (Domack et al., 2005). Furthermore, we were fortunate to land on the Robertson and Flamnes Island which had been under the Larsen Ice shelves and are exposed during the Holocene. Another sister of cosmogenic nuclides family such as in-situ ^{10}Be and in-situ ^{14}C will be analyzed from the bedrock and erratic boulder samples on the islands, which in turn, is likely to tell the more detailed history related to the growth and collapse of the Larsen ice shelves they experienced.

ANTARCTIC CLIMATE RECORD IN ILLITE CRYSTALLINITY AND CRYSTAL SIZE DISTRIBUTION

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ABSTRACT

Illite crystallinity (IC) and crystal size distributions (CSDs) are frequently used to determine the crystal growth mechanism in diagenetic condition or laboratory experiment. Recently, biotic process, particulary Fe-respiration was focused on the chemical/structural alteration of clay minerals, consequently resulting in the modification of clay packet size distribution. Here, we hypothesize that "the environmental changes in sediment deposition may be reflected in IC and CSDs during Holocene and Last Glacial Maximum (LGM)".

Total 238 cm of marine core sediments at Larsen C Ice Shelf, Antarctic Peninsula was collected during ARA13 CRUISE 2013 Expedition (4th April to 15th May, 2013). Clay size fraction less than 2μm was used to measure the IC (half-height width) for the various depths by X-ray diffractometer (XRD) and total ~600 of illite packet size (thickness, parallel to c*) were measured on the transmission electron microscopy (TEM) lattice fringe images.

Changes in IC (0.54 – 1.12) with depths may correspond to the temperature increase during interglacial period (Holocene), and show a compatible trend with other measurements for example ^{10}Be, total DNA, and TOC, suggesting biological/chemical effects on mineral alterations. Grain-size histograms of illite packets broaden, flatten and shift to larger sizes with decreasing depth. Calculated log normal distribution was plotted using α (mean of logarithms of the observations) and β^2 (variances of the logarithms of the observation), and compared with the CSDs for the observation. The observed illite CSDs with various depths follow a calculated log normal distribution with increasing α and β^2, indicating that illite pakets may grow in a surface-controlled open system.

Biological effects on the modification of CSDs will be discussed to collaborate with total DNA, TOC and ^{10}Be measurements with various depths during interglacial period.

POLAR MARINE DIATOMS: EXTENDING THEIR USE AS PALEOENVIRONMENTAL PROXIES IN THE ANTARCTIC PENINSULA

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ABSTRACT

Diatoms have a long history of study in the Southern Ocean and have proven to be critical elements in the reconstruction of past changes in glacial and sea ice extent, and physical and biological oceanographic conditions. These studies traditionally depended on diatom abundance and assemblage data, with newer work adding insights based on morphologic variability in valve shape that are hypothesized to be responses to changing sea surface temperature, water column stratification, and nutrient content. New diatom data from three sites in the Peninsula, from sediment cores from the Gerlache Strait, Perseverance Drift, and Larsen C provide clues regarding changes in Holocene paleoceanographic conditions that can be interpreted within the context of multi-proxy data sets being developed for these cores.

In Peninsula sediments, absolute diatom abundances range over several orders of magnitude, with hypothesized sub-ice lake sediments devoid of diatoms, grounding line proximal sediments with extremely low abundances of both fragmented and whole diatoms, and open water/seasonal sea ice settings characterized by variable but generally higher abundances, depending on the balance between flux from overlying productivity and dilution by terrigenous material, a factor especially critical in coastal sites where rapid loss of glacial ice introduces large amounts of lithogenic material to the water column. Assemblage data demonstrate significant biogeographic differences in dominant genera. *Chaetoceros* overwhelmingly dominates the western side of the Peninsula, likely due to the importance of an early spring bloom while sea-ice associated species of the genus *Fragilariopsis* characterize the eastern side of the Peninsula, the consequence of later sea ice breakout. *Chaetoceros* also dominate sediments from the northeastern tip of the Peninsula, but the added abundance of large *Thalassiosira antarctica* and small benthic diatoms are notable. The interpretation of *T. antarctica* is uncertain given the lack of modern observational data; the benthics reflect downslope transport of epiphytic diatoms living on shallow water macroalgae. Finally, detailed morphologic data from species such as *Eucampia antarctica, Thalassiosira antarctica* and *Fragilariopsis kerguelensis*, record changes in winter sea ice and the influx of circumpolar deep water onto the shelf, as well as changes in nutrient concentration.

LATE HOLOCENE PALEOCLIMATIC RECORD OF SEDIMENT NEAR JOINVILLE ISLAND: PRELIMINARY RESULTS

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ABSTRACT

A 4.7-m-long sediment core JV10 covering about 4000 years was collected from the Weddell Sea located near the Joinville Island (63° 15'S, 55° 45'W), the northern tip of the Antarctic Peninsula. The study area is influenced by both Weddell Sea Transitional Water and Upper Circumpolar Deep Water, so it can be a good site to study ocean circulation of Southern Ocean. Six AMS radiocarbon ages were determined by carbonate shells at the CAIS (Center for Applied Isotope Studies) at the University of Georgia. No age inversions were observed, implying a lack of reworking during deposition. Sedimentological, geochemical, and micropaleontological parameters were analyzed to reconstruct paleoenvironmental changes. The core was visually described and sliced for X-radiographs, and analyzed to determine magnetic susceptibility (MS) and the content of total organic carbon (TOC) and calcium carbonate ($CaCO_3$) content. Grain size is analyzed at 4 cm interval and diatom assemblage composition and abundance are analyzed at about 2 cm interval. Long chain alkyl 1,13- and 1,15-diols, specific lipids of diatoms of the genus Proboscia, are analyzed to test as a new proxy of sea surface temperature (SST). Chemosynthetic Bivalve shell Calyptogena sp. which is associated with the cold seep occurred at six horizons from ca. 4000 to 2500 yr BP. We postulate that the environment of study area was relatively stable during this period. It is consistent with the result of the James Ross Island close to the study area. After 2500 yr BP, MS, TOC, diatom abundance changed by about 500-year periodicity. This trend is being examined in terms of the Antarctic sea ice variability.

SEDIMENT GRAIN SIZE, SHAPE, AND TEXTURE OF THE PERSEVERANCE DRIFT, ANTARCTIC PENINSULA: TRANSPORT HISTORY AND IMPLICATIONS

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ABSTRACT

Ice pulled back from the shelf offshore the northern Antarctic Peninsula following the Last Glacial Maximum. Since then, sedimentary drift deposits have been forming, receiving sediment from a variety of sources. The Perseverance Drift is a 100 m thick sedimentary drift deposit at the northwestern tip of the Antarctic Peninsula; the drift deposit is composed of laminated, olive-colored diatomaceous mud and ooze, carbonate shells, and many horizons of ikaite crystals. This study, which is under the umbrella of the LARISSA project, is using a 24 m jumbo piston core collected in 2012 and is using grain size, shape, and texture of sediments in the Perseverance Drift deposit as tools to determine sediment transport history and variations in the relative roles of current transport, iceberg-rafted debris, and aeolian transport bring sediment to the site. Laser-particle-size analysis was conducted for grain size analysis every 5cm downcore. In each interval, clay content ranges from 8-19%, silt content ranges from 50-85%, and sand content ranges from 0-36%. The high percentage of sand is interpreted as a result of the winnowing of fine-grained sediments by ocean currents leaving behind a sandy lag, the release of ice-rafted debris during the melting of icebergs, and the drift deposit's proximity to exposed sediment along the surrounding islands allowing for aeolian transport of coarse material. Aeolian deposits contribute to the drift via the seasonal melting of sea ice and are a source of iron that triggers large phytoplankton blooms. Transport mechanism has a great influence on grain shape: as glacial influence decreases, grain roughness decreases and as glacial influence increases, grain roughness increases. Grain shape statistics of 52 intervals was measured. The majority of the grains from the drift deposit have low to medium sphericity values, indicating glacial transport; however, there are some smooth grains with high sphericity values, which indicate transport by either ocean currents or aeolian transport from surrounding sediment exposures. Plots of sphericity versus circularity allow determination of the respective transport history for each interval. Large mineral grains from the intervals of high and low sand content were chosen to study under the scanning electron microscope to examine the role of glacial transport by comparing the relative abundance of grain microtextures. The grains exhibit a high to medium abundance of these microtextures. By studying the differences in grain size, shape, and texture relative fluctuations in the different sediment sources and transport mechanism can be determined. We hypothesize that the intervals of higher abundance of aeolian transport may correlate to intervals of ikaite abundance.

RAMPED PYROLYSIS ^{14}C DATING OF SEDIMENTS: CASE STUDIES AND PROGRESS FROM ANTARCTIC SEDIMENTS

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ABSTRACT

Ramped pyrolysis ^{14}C dating is applied to materials that contain a mixture of organic carbon from different sources and potentially different ages. The underlying premise of the technique is that younger and more reactive organic carbon components will break down with less heat, whereas older more refractory components will stay intact to higher temperatures. When true, this premise should allow separation of different components of organic carbon while analyzing the entirety of organic carbon in the sample. Antarctic sediments are an ideal matrix to attempt this separation as they are largely devoid of carbonate macro and micro fossils and they are generally interpreted to be contaminated with older organic carbon from the continent via erosion of carbonaceous bedrock.

Here we present case studies that have allowed the continued development of this technique while advancing our understanding of Antarctic sediment chronology. Extending from early work demonstrating a proof of concept of the technique as well as a 10,000 y improvement in ages, we have shown that the assumption of constant age offsets can be fallible and that the material underlying the transition into submarine sedimentation can be meaningfully dated. Limitations still exist, and those will be discussed as well. At this point, the method promises, at least, a better understanding of geological uncertainty of a ^{14}C date and maximum age constraints. The full potential of the method extends well beyond that and into the realm of enabling chronology of ice shelf backstepping during the transition into the Holocene.

EARLY HOLOCENE RETREAT OF THE MARINE-BASED ICE SHEET IN THE CENTRAL ROSS SEA

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ABSTRACT

Establishing a reliable chronology for the retreat of marine-based ice sheets in the Ross Embayment since the Last Glacial Maximum (LGM) has proved challenging, in large part due to an absence of carbonate material in marine sediment cores from which precise radiocarbon chronologies can be obtained. Here, we report a lithofacies-based retreat history from the ANDRILL Coulman High drill site in the Central Ross Embayment. This site was located within the paleo-drainage path of the Byrd Glacier, the largest East Antarctic Ice Sheet outlet glacier draining in to the Ross Sea at the LGM. Planktic and benthic formaniferal-based radiocarbon dates from a laminated-diatom- and ice-rafted debris-bearing glacimarine mud constrain the retreat history of the Last Glacial Maximum (LGM) ice sheet in the Ross Embayment. This establishes that the modern-day calving line location of the Ross Ice Shelf was established by 9.5 ka BP, indicating that the majority of ice sheet retreat in the Ross Sea occurred prior to this time.

During post-LGM retreat of the ice sheet margin in western Ross Sea, and prior to the first open marine conditions at Coulman High, it is hypothesized that the grounding and calving line were in relative close proximity to each other. As the calving line became “pinned" in the Ross Island region, the grounding line likely continued its retreat toward its present day location, although if this occurred rapidly or gradually throughout the Holocene remains unknown.

We examine our results in the context of oceanic drivers and marine instability mechanisms for the LGM retreat of the ice sheets in the Ross Embayment. This will be acheived through comparison with recently published chronologies derived from marine sediment cores in the Amundsen Sea and Wilkes Land margin. Our results imply that the majority of post-LGM ice sheet retreat occurred in unison in all three sectors, which is consistent with the strong oceanic connections between the Amundsen and Ross Sea and Wilkes Land, via the Ross Sea Gyre and Antarctic Slope Current. We will also breifly discuss upcoming planned drilling in this sector of the Ross Sea as part of the ANDRILL and IODP drilling programmes.

CONNECTING HOLOCENE CLIMATE VARIABILITY IN ANTARCTICA TO THE MID LATITUDES VIA A NEW HIGH RESOLUTION RECORD FROM LAKE OHAU, SOUTH ISLAND, NEW ZEALAND.

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ABSTRACT

Lake Ohau (44°10'S, 169°49'E) contains a ~100+ metre-thick laminated sedimentary sequence that likely contains a >10,000 year long record of precipitation that primarily reflects changes in southern hemisphere westerly wind flow over the southern alps. On millenial and shorter timescales these changes appear to reflect the relative influence of the Southern Annular Mode (SAM) and El Niño Southern Oscillation (ENSO). A study of modern lake sediment processes, including short cores, sediment traps, temperature and turbidity data, river inflow and meteorlogical data demonstrates that Lake Ohau sediments reflect seasonal changes in lake sedimentation representing lake inflow and more broadly South Island precipitation. Short sediment cores (<6 m) from the lake contain mm- to cm-scale sedimentary couplets defined by colour and grain size changes. These cores have been dated by ^{137}Cs, ^{210}Pb and ^{14}C methods and show a sedimentation rate of ~5mm/yr and thus cover the last ~1200 years. Specifically, the pattern of downcore colour reflectance variability expressed in the sediments is very similar to climate model simulations of the SAM for the past 1200 years, suggesting that Lake Ohau has the potential to preserve a record of past climate change at synoptic and hemispheric scale.
The planned recovery of a 70 m long sedimentary core in 2015 will provide an unprecedented

opportunity to reconstruct South Island hydrology through the Holocene at decadal to annual timescales. The Lake Ohau core offers a new highly resolved mid-latitude record that can be compared with climate data derived from ice core and marine sediment records from Antarctica and the Southern Ocean to strengthen our understanding of climate connections in the SW Pacific.

SESSION

The Amundsen Sea as a Window to View the Future of the Antarctic in a Changing Global Climate

CROSS-FRONTAL FLUXES IN THE ACC NEAR UDINTSEV FRACTURE ZONE

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ABSTRACT

Across the Antarctic Circumpolar Current (ACC), fluxes of heat and momentum and other dynamical quantities establish the heat budget for the whole Southern Ocean, govern the strength of the ACC and its vital inter-ocean exchanges, and arguably govern the main pycnocline structure of the world oceans. Heat that melts glaciers along the Antarctic coast must have first crossed the ACC by a combination of mean and eddy heat transport mechanisms. The Udintsev Fracture Zone, northwest of the Amundsen study region and Pine Island Glacier, is a local "hot spot" of eddy activity in the lee of the ACC crossing the Pacific Antarctic Ridge. It is hypothesized that large southward mean and eddy heat transport occurs in that region. A particular question is how the relatively large eddy heat fluxes that occur along the northern ACC (SAF and PF) continue to cross further southward across the southern ACC (SACCF).
This study will deploy two arrays of Current and Pressure recording Inverted Echo Sounders (CPIES), for a period of 2 years, in order to observe and quantify exchanges of heat and dynamical quantities across the ACC. The methods and results will be described from a CPIES array in Drake Passage. The array locations near the Udintsev Fracture Zone (UFZ) have been selected because the SAF, PF, and SACCF converge closely together as they deflect equatorward where they encounter complex shallower ridges and exhibit strong eddy variability in the lee. Therefore, the UFZ emerges as a likely location for mean and eddy fluxes to conspire to cross the entire ACC enroute southward, ultimately affecting the Antarctic coast. This will be a collaborative study with a team of French and Korean scientists, who have been granted separate funding to deploy tall current meter moorings and conduct CTD surveys in this location. The French and Korean tall moorings will provide measurements of currents and temperature at fixed levels, providing complementary estimates of mean and eddy fluxes.

THE UDINTSEV FRACTURE ZONE EXPERIMENT: A STUDY FOR POLEWARD HEAT FLUX AND ACC VARIABILITY

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ABSTRACT

The Udintsev Fracture Zone (UFZ) located at the boundary between the Pacific Antarctic Ridge and Eastern Pacific Rise is a narrow choke point of the Antarctic Circumpolar Current (ACC). An ocean experiment to obtain time series data in the UFZ is planned as an international collaboration project. The project aims to address climate-relevant subjects such as the mechanism of the poleward oceanic heat flux and the ACC variability using in situ observations (current meters and inverted echo sounders moorings, surface floating buoys), altimetry, and numerical model outputs. It is designed to explore time series measurements via a Korea-France-USA collaboration, and to validate and use the global datasets from altimetry and the eddy-resolving, data assimilating model outputs for better documenting and monitoring the Southern Ocean heat budget and the ACC variability.

SEASOANL VARIABILITY OF BIOLOGICAL SOUND SCATTERING LAYERS IN THE AMUNDSEN SEA, ANTARCTICA

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ABSTRACT

Vertical migration of zooplankton is ubiquitous behavior in marine plankton community. Observations on diel, seasonal, and interannual variation of zooplankton behavior can support the knowledge for understanding of marine ecosystems. However, daily and seasonal rhythms are little observed in the deep-sea with seasonally ice-covered water. High-temporal resolution profiles of acoustic backscatter collected from a bottom-moored, upward-looking acoustic Doppler current profiler (ADCP) were deployed to describe the seasonal behavior of biological sound scattering layers under seasonally varying sea ice area with various conditions of surface solar radiation (SSR), sea ice concentration (SIC), and Circumpolar Deep Water (CDW) thickness. Multi-frequency acoustic backscatter data (38 and 120 kHz, EK60) were collected to identify the composition of DVM between fish and zooplankton using a dB differencing technique. The seasonal vertical distribution of sound scattering layers was clearly governed by the SSR, SIC, and CDW thickness: the depth of maximum mean volume backscattering strength was significantly correlated with SSR, SIC, and CDW thickness (r^2=0.79, $p<0.001$). Daily cycle of acoustic backscatter showed a distinct vertical distribution depending on the SIC. During low SIC, acoustic backscatter was associated with sun's periodicity (descent at sunrise and ascend at sunset), whereas during high SIC, high acoustic backscatter remained near bottom. These results might contribute to the knowledge about zooplankton ecology near bottom under ice-covered region at the high-latitude Southern Ocean. We also speculate that DVM of zooplankton can influence the accumulation and resuspension of organic matter near bottom as a contributor of biological pump.

OBSERVING VARIABILITY IN ANTARCTIC KRILL DISTRIBUTION IN THE SOUTHERN OCEAN: FROM DISCOVERY DAYS TO AUTONOMOUS VEHICLES

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ABSTRACT

Antarctic krill (Euphausia superba) is a key species in the ecosystem of the Southern Ocean, as a consumer of primary production, a major prey item of the many higher predators and the subject of a commercial fishery. The Discovery investigations (1926-1939) laid the foundation of our understanding of krill distribution, studying them as a key food of the commercially-fished whales. These first descriptions of distribution and life cycle were based on multiple seasons of sampling with a variety of nets, and still underpin our understanding of their circum-polar distribution.
In the 1960s, when krill themselves became the subject of a commercial fishery, concern was raised for the future of krill-dependant predators, as well as the krill themselves. This led to an international commitment to manage the fisheries sustainably through the development of the Commission for the Conservation of Antarctic Marine Living Resources (CCAMLR).The first multi-national survey of krill distribution using then novel acoustic technology (FIBEX, First International BIOMASS Experiment) was undertaken in 1980. A second large-scale, multi-national survey in the Scotia Sea, South Atlantic in 2000 (CCAMLR 2000 synoptic survey), presently provides the estimate of standing stock biomass used to calculate the precautionary catch limit for Antarctic krill.
In recent years climate induced change such as a reduction in sea ice extent and duration, increasing sea temperatures, and ocean acidification have been recognised as additional pressures on the Antarctic marine ecosystem and particularly krill abundance and distribution. Time-series measurements are required to understand the influence of these pressures on the inherent seasonal variability of krill distribution. However, long-term shipboard measurements in challenging environments introduce factors of safety and cost that can prove economically challenging. Autonomous vehicles are now paving the way to lower cost and longer timescale observations.

RECENT OBSERVATIONS OF GREENHOUSE GASES IN THE PACIFIC SECTOR OF THE SOUTHERN OCEAN ONBOARD R/V ARAON

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ABSTRACT

Korean ice-breaking research vessel Araon has been conducted scientific expedition at sea since 2010. Since then we have carried out measurements of diverse trace gases in both the marine boundary layer and the mixed layer of the sea to estimate their sink or source strengths of the oceans at high latitude. The greenhouse gases measured are CO_2, CH_4, N_2O, CO, and H_2, which are substantially important to the current global climate change. The ocean plays a wide range of role in the budget of these gases of the atmosphere: as a sink for CO_2 and a source for CH_4, N_2O, CO and H_2. High latitude of the Southern Ocean is particularly important as the current rapid change in the cryosphere can impact the ecological and physical settings that govern the content and flux of these dissolved gases in seawater. We have visited the Amundsen Sea threefold in the austral summer seasons of 2010/2011, 2012, and 2013/2014 and the Ross Sea in 2013. In addition to the expeditions in the Amundsen Sea, we had opportunity to survey the Pacific sector of the Southern Ocean in 2009 onboard R/V Polarstern. In the open ocean, CO_2 in the seawater was mostly undersaturated, CH_4 was slightly undersaturated, and N_2O and CO were supersaturated with respect to that in the marine boundary layer. These features were not observed in the sea-ice region; CO_2 in the seawater was slightly supersaturated in 2011, but not in 2012, and CH_4 in the seawater was undersaturated while dissolved N_2O and CO were supersaturated for both years. In the polynya of the Amundsen Sea, CO_2 and CH_4 were depleted in the seawater while N_2O and CO in the seawater were supersaturated with respect to those in the atmosphere. Based on these 3-year observations during austral summer season, high latitude of the southern ocean contributes as a sink for atmospheric CO_2 whilst as a source for N_2O and CO. In the case of CH_4, the open ocean was slightly undersaturated overall, which differs from the role of the ocean in the global scale.

HIGH PROTEIN INCORPORATION OF PHYTOPLANKTON IN THE AMUNDSEN SEA

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ABSTRACT

Using ^{13}C isotope tracer technique, macromolecular productivity experiments of phytoplankton were executed to investigate physiological conditions of phytoplankton in the Amundsen Sea during late summer season in 2012. Based on Lee et al. (2009), the differential extractions of macromolecular classes (LMWM, lipids, proteins, and polysaccharides) were performed. Generally, high carbon incorporations of phytoplankton into proteins were found throughout the euphotic zone in the Amundsen Sea. In comparison, other classes were found relatively low contribution to the macromolecular compositions. The overall average allocations were 18.1% (S.D. = ± 9.72%), 21.4% (S.D. = ± 12.3%), 2.4% (S.D. = ± 5.9%), and 58.1% (S.D. = ± 13.8%), respectively, for LMWM, lipids, polysaccharides, and proteins. Based on previous studies, this suggests that phytoplankton had no nitrogen limitation and a physiologically healthy condition. In this study, we did not find any vertical trend for compositions of LMWM, polysaccharides, and lipids but protein contribution had a decrease trend from surface to 1 % light depths. If the high carbon incorporation into proteins by the phytoplankton in this study is a general pattern of the photosynthetic allocations in the Amundsen Sea, they could provide nitrogen-sufficient food for higher trophic levels.

RESONANT ROSSBY WAVES ON THE OUTER CONTINENTAL SHELF IN THE AMUNDSEN SEA

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ABSTRACT

Mooring data from the western flank of the deep Dotson Trough are presented with focus on short-term variability. The data show the presence of strong barotropic oscillations with period 40-60 hours. The oscillations are visible in velocity, temperature, salinity and pressure. The period corresponds to topographic Rossby waves of near-zero group velocity and wavelength 150 km, i.e. the double channel width. It is suggested that the oscillations are resonant topographic Rossby waves which are blocked (i.e. zero normal velocity) in the shallow end and free (i.e. zero normal velocity shear) in the deep end. The simplified analytical theory for Rossby waves on a constant bottom slope is compared with the results of a numerical model developed by Brink in 1986. The results are qualitatively similar, although the numerical model has zero group velocity for frequencies very close to the observed while the analytical model has zero group velocity for somewhat lower frequencies.

STRONG SENSITIVITY OF PINE ISLAND ICE-SHELF MELTING TO CLIMATIC VARIABILITY

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ABSTRACT

Pine Island Glacier has thinned and accelerated over recent decades, significantly contributing to global sea-level rise. Increased oceanic melting of its ice shelf is thought to have triggered those changes. Observations made by an autonomous underwater vehicle and from Research Vessels between 1994 and 2014 reveal large fluctuations in the ocean heat available in the adjacent bay and enhanced sensitivity of ice shelf melting to water temperatures at intermediate depth, as a seabed ridge blocks the deepest and warmest waters from reaching the thickest ice. Oceanic melting decreased by 50% between January 2010 and 2012, with ocean conditions in 2012 partly attributable to atmospheric forcing associated with a strong La Nina event. Both atmospheric variability and local ice shelf and seabed geometry play fundamental roles in determining the response of the Antarctic Ice Sheet to climate.

CIRCUMPOLAR DEEP WATER TRANSPORT IN THE AMUNDSEN SEA: THE REPRESENTATION OF ANTARCTIC SHELF WATER MASSES IN THE CMIP5 MODELS AND IMPLICATIONS FOR THE MASS BALANCE OF THE ANTARCTIC ICE SHEET

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ABSTRACT

Mass loss of the Antarctic ice sheet occurs predominantly through iceberg calving and ice shelf basal melting. In addition to the shape of the sub-ice shelf cavity and circulation strength, the rate of basal melting is strongly influenced by the temperature of seawater that has access to them. The presence of warm Circumpolar Deep Water (CDW) intrusions on the Amundsen continental shelf has been linked to recent thinning of the outlet glaciers draining the West Antarctic Ice Sheet into the Amundsen Sea. CDW is sourced from within the Antarctic Circumpolar Current (ACC) situated well north of the glacial ice fronts. To be able to access the Amundsen Sea glaciers, CDW must first cross the continental shelf break.

Studies based on recent observations and regional model results have emphasised the role of shelf break depressions and troughs as conduits of CDW transport onto the Amundsen shelf. We will present results from a shelf break depression located at 113°W at the Amundsen shelf break. Observations and model results show the importance of an eastward undercurrent for on-shelf transport of CDW. They also indicate that CDW layer thickness varies on interannual timescales with a thin CDW layer around the year 2000 and a thickening between 2006 and 2009 in agreement with observations on the inner shelf. In addition, mooring results indicate a seasonal cycle of CDW layer thickness with a thinner summer and a thicker winter layer.

Projections of future mass loss of the Antarctic Ice Sheet and its contribution to global sea level rise thus depend crucially on the representation of Antarctic shelf water masses in global climate models, especially if ice sheet components are to be included in the next generation of these models. We assess the present day representation of shelf water masses on the Amundsen Sea continental shelf in the CMIP5 models using these recent observations. Our present understanding of the processes controlling on shelf transport of CDW will be used to appraise the projected changes in future model scenarios and their implications for mass loss of the West Antarctic Ice Sheet over the next century.

GLIDER OBSERVATIONS ALONG THE DOTSON ICE SHELF

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ABSTRACT

Onshore along-channel flow of warm circumpolar deep water (CDW) through glacially cut troughs on the continental shelf of the Amundsen Sea has been shown to contribute to basal melt of glaciers. A Teledyne-Webb Slocum autonomous underwater vehicle (AUV), RU25D, was deployed during the 2014 Korean Polar Research Institute (KOPRI) Amundsen research cruise to compliment shipboard surveys by collecting high spatial- and temporal- resolution observations along the Dotson Ice Shelf. The glider observed a clear CDW signature near bottom, with temperatures of over 0°C, salinities over 34.4 PSU and oxygen saturation near 55% as well as a distinct CDW water mass on the shallow western flank of the trough, which extended up to depths as shallow as 150 meters. Directly in front of the glacier the glider identified basal melt waters between 100 and 200 meters with temperatures of -1.4°C, salinities below 34 PSU and oxygen saturation near 75%. With further data analysis we hope to identify estimates of onshore and offshore heat flux as well as investigate the potential for mixing between surface and CDW waters on the shallow western flank of the trough in front of the Dotson Ice Shelf.

SESSION

Interactions between the Solid Earth, the Oceans and the Cryosphere in the Victoria Land-Ross Sea, Antarctica

AIRBORNE STUDIES OF SUBGLACIAL BOUNDARY CONDITIONS IN WEST ANTARCTICA

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ABSTRACT

Hydrologic, lithologic, and geothermal basal boundary conditions can exert strong, even dominating, control on the evolution, stability, and sea level contribution of ice sheets and glaciers. However, the scales at which the physical processes and observable signatures of this control occur are typically smaller than the spatial resolutions currently achievable using ice penetrating radar. Further, the strength of radar bed echo returns is affected by the material and geometric properties of the bed as well as englacial attenuation from unknown ice temperature and chemistry, making assessment of basal conditions from echo strengths difficult. To address these challenges in interpreting basal properties at glaciologically relevant scales, a new algorithmic approach is applied to measuring the radar scattering function of the bed in terms of the relative contribution of angularly narrow specular energy and isotropically scattered diffuse energy. This relative specularity content is insensitive to englacial attenuation and can be used to constrain the geometry of the bed down to the centimeter scale. This approach is applied to an airborne radar sounding survey of Thwaites Glacier, West Antarctica using the information in the along-track scattering function to assess the extent and geometry of water across the catchment and detect the transition of that water from distributed canals to concentrated channels. This information is also used to constrain the morphology of subglacial bedforms and infer that the distribution of deformable sediments and exposed bedrock is similar to deglaciated paleo ice streams that experienced meltwater intensive retreats. Finally, models of radar echo strength and subglacial water routing are compared to estimate a catchment-wide distribution of geothermal flux consistent with rift-associated magma migration and volcanism. These observations of basal conditions provide new context for the past, current, and future evolution of Thwaites Glacier, the West Antarctic Ice Sheet, and their contribution to global sea level.

LONG-TERM (1979-2012) ICE MASS LOSS ACCELERATION IN ANTARCTICA

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ABSTRACT

Recent observation of the ice mass loss acceleration in Antarctic Ice Sheet (AIS) projects the significant rise of the global sea level in near future while its mechanism is not certain. We examine the cause of the acceleration in AIS with GRACE and ERA-Interim data from 2003 to 2012. The acceleration patterns from satellite gravity and reanalysis are highly correlated (r=0.97) implying that the acceleration in the continent is mainly associated with the change of net surface accumulation. Based on the excellent agreement between the GRACE observation and reanalysis, we extrapolate the surface accumulation in AIS back to 1979. The long-term AIS surface accumulation is validated by satellite laser ranging observation. About three decades AIS surface accumulation shows that the recent acceleration pattern is minor compared to the larger oscillation pattern from 1979 to 2002. This result underscores that climate variability plays a significant role in AIS mass balance, and the AIS mass loss acceleration during 2003-2012 is not unprecedented.

MEASURE FOR MEASURE: USING MODELS TO SYNTHESIZE HETEROGENOUS OBSERVATIONS OF CHANGE IN WEST ANTARCTICA

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ABSTRACT

The West Antarctic Ice Sheet has the potential for rapid and significant change due to its marine character and fast-flowing ice streams. This makes modern change detection of particular interest. That objective is complicated in the Ross Sea sector of the ice sheet by internally-driven flow variability on time scales randing from annual to multi-century. Studies of ice flow in the recent past (the last few 1000 years), for which a record exists in ice morphology, help identify the processes and conditions that determine characteristic spatial and temporal scales.

Surface velocity has been measured in the Ross Sea sector of West Antarctica since the Ross Ice Shelf Geophysical and Glaciological Survey (1973 to 1978) but those measurements are episodic in time fragmented in space. Weaving them together into one conherent history of change requires synthesis of different types of observations in a process framework, a goal that can be met using high resolution numerical models of the ice sheet and ice shelf system. Here, the relationship between past change recorded in ice morphology and contemporary observations is explored for examples at the outlets of Whillans and MacAyeal Ice Streams.

OCEAN FORCING OF ICE-SHEET MARGINS: THERMODYNAMICS AND TIDAL EFFECTS

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ABSTRACT

Ice shelves and their tributary ice streams can be strongly forced by the ocean through both melt/freeze processes and tidal effects. While basal melting of ice shelves drives mass loss and grounding-line retreat, information gained from analyzing responses to tidal forcing can be valuable in projecting this retreat. The first part of the talk will cover results from idealized coupled ocean-ice shelf-ice stream models, including basal slope/melt feedback, effects of spatially varying melting, and the importance of vertical mixing in the ocean to the coupled system. In the second part of the talk, viscoelastic modeling of ice-stream response to tides will be discussed, including deriving bed characteristics from the upstream propagation of the tidal signal and studying how various ice-shelf processes lead to perturbations of ice-stream flow. Both studies of tidal forcing focus on analyzing GPS measurements from Bindschadler Ice Stream, West Antarctica.

ANTARCTIC'S SIREN CALL: THE SOUND OF ICEBERGS

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ABSTRACT

While the steady increase in global shipping traffic has been identified as a primary cause of rising ocean noise level, in the southern hemisphere the disintegration of large icebergs was found to be a significant noise source that influences the soundscape of entire ocean basins. Two large icebergs B15 and C19 calved off the Ross Ice Shelf in early 2000s. In late 2007, B15a and C19a, still area size of ~5,500 km^2 and 1800 km^2 respectively, have started driftingd eastward to the warmer South Pacific Ocean. For the next 1.5 years, while these icebergs were rapidly melting in the water between 50^{o}S and 60^{o}S (Figure 1), they not only affected water circulation and marine ecosystem in their vicinity but also from 2008 to early 2009, continuous disintegration projected loud low frequency sounds into the water column. The sounds propagated efficiently through surface layer to deep water sound channel in lower latitudes, influencing the soundscape of the entire South Pacific basin. In early 2008, the icebergs' sounds have started influencing the ambient noise level in the South Pacific Ocean and were recorded by the deep-water hydrophone array Juan Fernandez Island (34^{o}S, 79^{o}W) maintained by Comprehensive Nuclear-Test-Ban Treaty Organization (CTBTO). The iceberg sounds propagated across the equator and were recorded by the hydrophone array in eastern equatorial Pacific maintained by Pacific Marine Environmental Laboratory at National Oceanic Atmospheric Administration and Oregon State University. At these locations, noise level rose by ~+7 dB and ~+3 dB above the baseline years at respective locations in 30-36 Hz range (Figure 2). Spectrogram shows that at CTBTO hydrophone location, the icebergs' sounds dominated frequency range below 100 Hz in which baleen whales vocalize. Some large icebergs in the Southern Ocean have life spans over a decade and can potentially project low frequency sound energy for a long period. We discuss that icebergs calved off Antarctica can collectively generate a considerable amount of sound energy, which then propagates across ocean basins, influencing the ocean acoustic environment for the duration of the iceberg's disintegration.

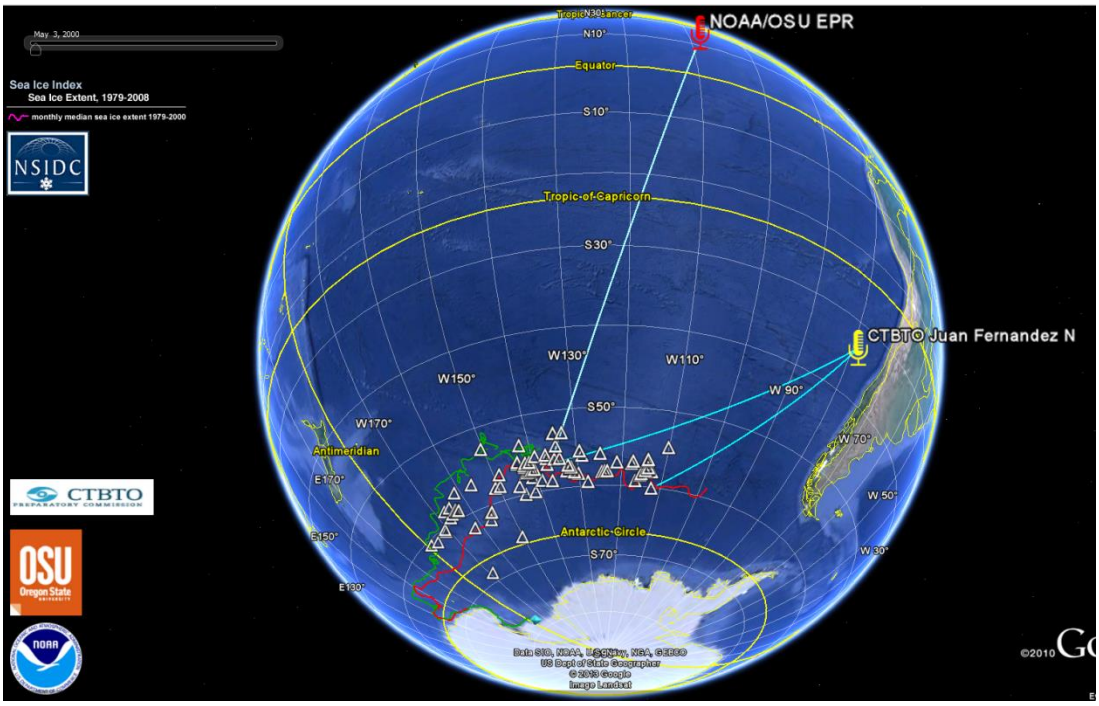

Figure 1. Satellited tracks of B15a (green) and C19a (red) and acoustically located iceberg sounds sources (white triangles). From 2008 to early 2009, the two icebergs generated acoustic noise strong enough to be detected by CTBTO Juan Fernandez hydrophone (34ºS, 79ºW) and NOAA/OSU EPR hydrophone (8ºN, 110ºW), at distances ~7,000 km to ~3,500 km and ~10,000 km to ~7,500 km respectively.

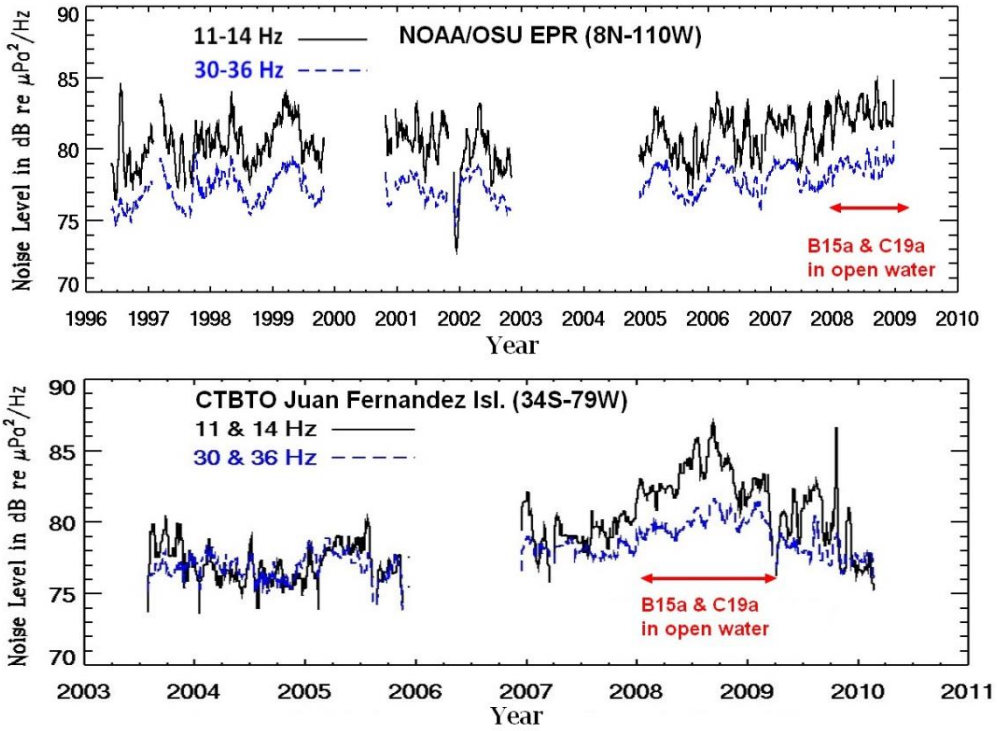

Figure 2. Long term acoustic noise levels at NOAA/OSU EPR and CTBTO Juan Fernandez hydrophones. Noise level below 100 Hz rose at both locations during B15a and C19 were disintegrating in 2008 to early 2009. In 11-14 Hz (black) and 30-36 Hz (blue), it has risen approximately +5 dB and

+3 dB at NOAA/OSU EPR, and +10 dB and +7 dB at CTBTO hydrophone respectively above the baselines

ANTARCTICA AND THE GLOBAL NEUTRON MONITOR NETWORK

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ABSTRACT

The southern hemisphere is mostly water. As a result, careful placement of land based instrumentation is particularly critical. A neutron monitor is an instrument that measures the number of high-energy particles impacting Earth from space. For historical reasons these particles, mostly protons and helium nuclei, are called "cosmic rays." Because the intensity of cosmic rays hitting Earth is not uniform, it is important to place neutron monitors at multiple locations in order to form a complete picture of cosmic rays in space. In turn the variations in cosmic ray flux are diagnostic of magnetic fluctuations that are behind much of what is now referred to as “Space Weather.” I discuss the planned relocation of the neutron monitor at McMurdo to the Korean station Jang Bogo in the context of the overall importance of Antarctica to the global neutron monitor network.

THE STRUCTURE AND EVOLUTION OF THE ROSS SEA

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ABSTRACT

The geological structure and history recorded in the Ross Sea provide constraints and insights into the evolution of the Antarctic cryosphere as well as on the tectonic development of the region. However, our knowledge of the geological structure and evolution of the Ross Sea and its past environment is based on limited direct geological information supplemented by a broad coverage of geophysical data. Oceanic magnetic anomaly data provide plate tectonic constraints on the evolution of the region, requiring some plate boundary deformation through the region during the Tertiary. Offshore direct geological data are sparse apart from near surface sediments, sampled by piston coring. Several drilling projects have recovered sediments as old as Late Eocene, with two drill holes sampling basement. However, these drill holes are mainly concentrated in the McMurdo Sound region with only four sites in the most of the Ross Sea. These data can be extrapolated into the remainder of the Ross Sea by seismic and other geophysical studies but there is a lack of good age control for large parts of the sedimentary sequences. The drill core data have defined icesheet proximal past environmental conditions in detail, including cyclical events. The combined data sets have defined the major structures in the Ross Sea – the four major sedimentary basins (Victoria Land (VLB), Northern, and Eastern Basins and the Central Trough) and major faulting through the Ross Sea - and their development over the past 100 Ma approx. Structures imaged in these data provide a record of Antarctic glacial and tectonic history. The continuation of these structures south under the Ross Ice Shelf has been inferred but is not well constrained. Restoring past topography of the region by reversing its tectonic history indicates that the morphology of the region may have been quite different when glaciation commenced in the region, providing new constraints for the initiation of the icesheet. At the seafloor and in the upper sediments, BSRs, pock marks and mud volcanoes have been documented, along with sub-glacial features such as grounding zone wedges. Detailed bathymetric data record sub-ice sheet processes, including moraines, lineations, and iceberg furrows that document the past movements of the ice sheet across the Ross Sea. Sub-glacially erupted volcanic edifices have been inferred within the Ross Sea. The change in style of rifting along western Ross Sea and Adare basin may provide a constraint on how continents rift.

P-WAVE VELOCITY STRUCTURE BENEATH MT. MELBOURNE IN NORTHERN VICTORIA LAND, ANTARCTICA: DEEP LVZ AND ITS SHAPE

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ABSTRACT

The P-wave velocity structure of the shallow upper mantle beneath Mt. Melbourne was modeled from the double precision teleseismic inversion method [VanDecar, 1991]. The teleseismic events used in this study were obtained from the Korea Polar Seismic Network at Terra Nova Bay (KPSN@TNB), which consisted of five broadband seismic stations deployed from 2001. The 1501 relative P-wave traveltime residuals were computed from 402 events using the multichannel cross correlation (MCCC) method [VanDecar and Crosson, 1990]. The inverted velocity model reveals two separate low-velocity regions; one is beneath Mt. Melbourne and trending N-S direction between 40 - 90km depths, and the other is beneath the KP03 station and extending to NW direction. The low velocity anomaly smeared downward along the raypaths in the model space of the outside the KPSN@TNB. However, several resolution tests confirmed that our model is reasonably good for the model space within the network. The low velocity anomaly beneath Mt. Melbourne is associated the uplift of and volcanic center.

SOURCES OF LONG-TERM AMBIENT OCEAN SOUND NEAR THE ANTARCTIC PENINSULA

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ABSTRACT

Hydrophone arrays (250–1000 Hz) were deployed within the Bransfield Strait and Scotia Sea (Antarctic Peninsula region) from 2005 to 2009 to study sources of ambient ocean sound. Icequakes, which are broadband, short duration signals derived from fracturing of large free-floating icebergs, are a prominent feature of the ocean soundscape. Icequake activity peaks during austral summer and is minimum during winter, likely following freeze-thaw cycles. Iceberg grounding and rapid disintegration also releases significant acoustic energy, equivalent to large-scale geophysical events. Overall ambient sound levels can be as much as ~10–20 dB higher in the open, deep ocean of the Scotia Sea compared to the relatively shallow Bransfield Strait. Noise levels become lowest during the low annual temperatures of the austral winter, likely due to freezing of regional sea ice of all scales. Ambient noise levels are highest during austral spring and summer, presumably due to melting and cracking icebergs. Vocalizations of blue (Balaenoptera musculus) and fin (B. physalus) whales also dominate the long-term spectra records in the 15–28 and 85 Hz bands. Blue whale call energy is a maximum during austral summer-fall in the Drake Passage and Bransfield Strait when ambient noise levels are a maximum and sea-ice cover is a minimum. Fin whale vocalizations were also most common during austral summer-early fall months in both the Bransfield Strait and Scotia Sea. The hydrophone data overall do not appear to show sustained anthropogenic sources (e.g. ships), likely due to low coastal populations and the difficult marine conditions of the Southern Ocean.

CHARACTERISTIC CRYOSEISMIC AND OCEANIC WAVES ASSOCIATED WITH SURFACE ENVIRONMENTS AT THE LÜ TZOW-HOLM BAY, EAST ANTARCTICA

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ABSTRACT

In an international geoscience prospect at the IPY, the 'Polar Earth Observing Network (POLENET)' was the largest contributions in establishing a seismic and GPS network in Antarctica. Several kinds of environmental signals associated with the atmosphere - ocean – cryosphere - solid earth systems were detected in the continental margins and surrounding oceans. Ice-related seismic motions for small magnitude events are generally named 'ice-quakes' ('ice-shocks') and can be generated by glacially related dynamics (Kanao et al., 2012). Such kinds of cryoseismic sources are consisted from the movements of ice sheets, sea-ice, oceanic tide-cracks, oceanic gravity waves, icebergs and the calving fronts of ice caps. Nettles and Ekstrom (2010), moreover, determined the hopocenter and magnitude of several large ice-quakes (glacial earthquakes) around Antarctica by using the long period surface wave data. These hypocenters locate mainly at the outlet of the large glaciers, otherwise the edge of ice shelves. Cryoseismic and oceanic waves (microseismis) are likely to be influenced by the variations in environmental conditions, including lower atmosphere, and the continuous study of their time-space variation provides indirect evidence of climate change. In this presentation, several characteristic features of cryoseismic waves observed the stations around the Lützow-Holm Bay (LHB) region are introduced, involving the surface environmental variations in vicinity of the area from continental coastal to the southern ocean. Hypocenters of local events, waveforms invlolving discharge of sea-ice, tide relating signals, as well as the tremor signals with characteristic frequency contents are demonstrated. As the glacial earthquakes are the most prominent evidence found recently in the polar region, these new innovative studies of polar seismology has been achieved on the basis of observational experiments and long-term monitoring under the extreme conditions in polar environment.

SESSION

Life of King George Island in the Changing Environment

COASTAL MARINE MONITORING AT THE KING SEJONG STATION, KING GEORGE ISLAND (KGI), ANTARCTICA

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ABSTRACT

KGI is maritime Antarctica, and it is located at the northern tip of the Antarctic Peninsula, one of the most rapidly warming regions on Earth. About 90% of the island is covered by glaciers, and significant glacier retreat has been observed in many coastal areas. KGI is also most crowded region in Antarctic, where 8 countries are operating their stations all year round. All these stations are located on the coastal area. Thus, coastal environment of KGI is likely to be the most sensitive area to climate change and anthropogenic impacts, which warrants a long-term monitoring on coastal marine ecosystem changes. Marine monitoring at KSS consists of largely 2 parts: year-round monitoring (environmental monitoring at a fixed point) and summer-time monitoring (monitoring on glacier retreat and its impacts on water column properties and planktonic/ benthic communities).

We initiated a year-round long-term monitoring on marine environment in 1996 at KSS, and thereafter we've been collecting environmental data (i.e. water temperature, salinity, nutrient, and Chl.a etc.). We've been also continuously monitoring seasonal & annual variations in species composition and biomass of microalgal populations, relating their changes to the environmental variables measured. We found different diatom species increased towards the tidewater glaciers in Marian Cove (MC), a typical glacial fjord in Maxwell Bay. Sea ice condition and meteorological parameters are being monitored since the operation of KSS in 1988.

Starting lately, we've been monitoring ice retreat and its impacts on marine organisms in Marian Cove. During the last 50 years, the tidewater glacier in MC has been retreated about 2 km. We've been seeing the ice retreat being accelerated in recent years. MC receives a substantial amount of glacier-melt water during austral summer months. In order to understand how glacier-melt water affects sea water properties we're conducting time-series measurement of sea water parameters using CTD casting and tide gauges moored in the cove. We found distinct gradients in water column properties and in concentrations of some terrestrial elements (i.e. SPM, Fe, Al) along the horizontal axis of a varying degree of melt-water influence. We're also assessing the climate-induced impacts on biodiversity and other ecological features of marine benthic communities. Slow-moving or sedentary benthic organisms in shallow (<35m) waters are likely the most vulnerable, which in turn enables them to serve as indicators of climate-induced perturbations.

Finally we propose a future monitoring program in KGI within a frame of international collaboration.

STUDY ON FORAGING HABITAT OF PENGUINS BY BIO-LOGGING APPROACHES: TOWARD THE MONITORING OF ANTARCTIC COASTAL ECOSYSTEM

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ABSTRACT

Objectives
Antarctic krill (*Euphausia superba*) and *Pygoscelis* penguins are key components characterising coastal ecosystem in northern part of Antarctic Peninsula region. In the top trophic level of the ecosystem, a decline in Adélie (*P. adeliae*) and chinstrap (*P. antarcticus*) penguins accompanying an increase in gentoo (*P. papua*) penguins over recent decades has been highlighted in relation to regional warming events. However, little is known about underlying process that makes such contrasting ecological response. In this context, characterising species-specific foraging habitat of the penguins at fine scale in relation to surrounding environment will provide better understanding about how top predators respond to local environmental change. In this study, we aimed to investigate at-sea foraging locations of the penguins and to characterise their habitats in relation to local marine environment, by using recently developed animal-borne data loggers.

Methods
The study was conducted at Barton Peninsula, King George Island, Antarctica (62º14.30'S, 58º46.50'W), where chinstrap and gentoo penguins breed sympatrically. Study period was between early December to early February of 2006-2007 and 2009-2010 austral summer seasons, which covered the chick-guarding period for both species. We used 2 types of loggers to characterise the foraging habitat: 1) GPS loggers: recording the foraging locations (resolution<10m) every seconds as well as dive depth and water temperature (D and T), 2) camera loggers: taking underwater still images every 5 seconds with D and T. The loggers were attached on back of the penguins. At the same time, we collected the food samples delivered to the chicks.

Results and discussion
Foraging locations detected by GPS loggers showed that chinstrap penguins used off-shelf habitat (bottom depth>200m) more frequently, with an inter-annual variation (76.7±28.2 and 82.0±27.6% of total dives in 2006-2007 and 2009-2010 seasons: Fig 1 left), compared with gentoo penguins (28.6±27.8 and 63.7±38.8% for 2006-2007 and 2009-2010 seasons: Fig. 1 right).

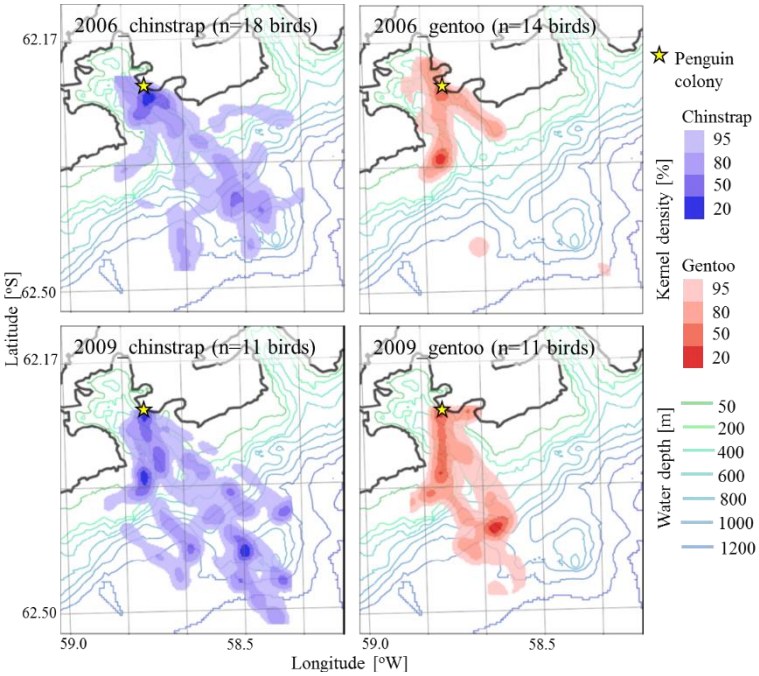

Fig. 1. Foraging location of chinstrap (left) and gentoo (right) penguins in two seasons investigated by GPS loggers.

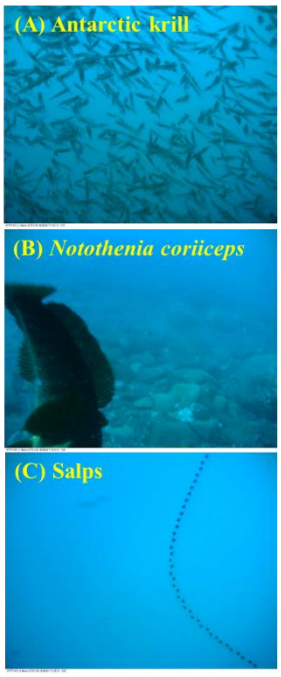

Fig. 2. Underwater still images taken by camera loggers attached on the penguins.

The underwater still images taken by camera loggers showed that both penguins encountered krill patches at similar rates (dives with krill images among all "light" dives: 28.7% for chinstrap and 33.8% for gentoo penguins, on average, in 2009-2010 season), with occasional encounter with salps (Fig. 2). Also, it revealed the krill patches were observed in both pelagic and benthic habitat, whereas salps were rarely observed in benthic habitat. Main food items of both penguins was Antarctic krill throughout the study period. These results suggest the existence of different types of krill habitat: 1) benthic habitat in on-shelf region, and 2) pelagic habitat in off-shelf region. We hypothesise that the different population trend of the penguins may reflect their species-specific foraging habitat use. This hypothesis can be tested more clearly by adding data from different years, given the inter-annual variation in the foraging habitat use.

THE CHILEAN ANTARCTIC PROGRAM: PROJECTING INTO UNCHARTED WATERS

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ABSTRACT

The Chilean Antarctic Institute has been conducting research programs in the South Shetland Islands in general and the Fildes Peninsula in particular, for over 40 years. Recent changes in INACH's funding scheme have boostered science quality and quantity, from 20 to >60 projects and 20 times more funding, bringing on new challenges. A review of the Chilean Antarctic Science program is presented, with examples of current scientific and logisitic accomplishments and limitations. Our program benefits from the country's proximity to the Antarctic Peninsula and transport facilities available in the region, covering many locations on the South Shetland Islands and the northwest Antarctic Peninsula. Research lines include the common evolution of South America and the Antarctic Peninsula, microbial ecology, and species and communities adaptation to climate change, with terrestrial plant, algae and marine invertebrate's phylogeography and ecophysiology being the strongest lines of research. By contrast, ecosystemic and marine (open water) studies remain weak in the program. This realization has brought the National Antarctic Science Program into a new stage, impulsed both by the acquisition of a small oceanographic vessel and plans for building a research ice breaker, as well as a change in the design of our science program. Key directives for the latter include valuing multidisciplinary and international collaboration as prerequisite for many grants, and a bottom-up phylosophy on science and logisitic planification, which along with targeted top-down agreements, opens new opportunities for international collaboration, as with the Korean program.

ESTABLISHING A MODEL ORGANISM FOR POLAR RESEARCH

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ABSTRACT

Model organisms have contributed for studying animal evolution and other fundamental biological knowledge in decades. Now, the number of comprehensive model organism has been developed for specialized research interest such as therapeutic approach, epigenetic regulation and organ regeneration etc. However, most biological research has long relied on a small number of well-established model organisms, we are aware of limitations to expand our interest, basic biological knowledge and evolutionary mechanisms of the polar-adapted species.

Copepods, the small crustaceans, are dominant components of the world's freshwater and marine ecosystems by their large biomass and ubiquity. They are also biologically important as key components in the foodchain, sensitive indicators for environmental change, vectors of disease and an important group for studying the evolutionary lineage in arthropods. They are highly diverged with long evolutionary history and can survive temperatures below 0℃ in polar regions and 45℃ hot springs. The ability of copepods to survive wide range of environments suggests that copepods can be genomic resources for physical, chemical and biological studies in polar research. For examples, polar copepods are characterized by very high levels of wax esters comprising more than 90% of the total lipids and the development of young stages depend on temperature in spring and summer in polar region. Unfortunately, polar organisms are less considered to be developed as laboratory species, first because they are uneasy to be captured and second because of difficulty to be cultured.

We have cultured the Antarctic copepods to examine the potential as laboratory research organisms. We want to increase our knowledge of polar species and our skill in laboratory working with them to be improved. We hope then, a candidate species becomes established as a model, therefore accumulating a valuable resource of information also for polar research projects. Due to advanced sequencing technology, large-scale approaches such as genomics and proteomics have become an essential part of model organism research. We are doing sequencing, gene expression studies and genome comparative analysis concurrently.

EXPLORING MICROBIAL DIVERSITY IN ANTARCTIC TERRESTRIAL ECOSYSTEMS

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ABSTRACT

Antarctica, the fifth-largest continent is the coldest and driest continent. For several decades, terrestrial environments in this continent had been believed as sterilized habitats without any life forms because of the severe environmental condition. With the efforts of terrestrial biological research, we are now beginning to understand the uniqueness and complexity of these fragile ecosystems and to stimulate further studies in many aspects. Molecular methods in microbiology have enlarged the field and our understanding. Through the use of these techniques, it is revealed that microorganisms are much more diverse than we expected before and play important roles in these harsh environments. Our main research projects focus on understanding microbial life in terrestrial ecosystems in Antarctica. Ongoing project is to study microbial diversity on King George Island, around Terra Nova Bay, in Victoria Land along the latitudinal gradient and in Lakes of the Dry Valleys. Here in this talk, some preliminary results will be presented and discussed.

SOME LIKE IT HOT: GLOBAL-SCALE MICROBIAL DISPERSAL REVEALED IN THE FUMAROLIC SOILS OF TRAMWAY RIDGE, MT EREBUS, VICTORIA LAND

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ABSTRACT

High-altitude, geothermally heated fumarolic fields in Antarctica are analogs for similar environments that may have supported pockets of life during "Snowball" periods in Earth's history or that exist today on icy terrestrial planets. These habitats provide a valuable resource for studying the evolution of mechanisms that enable global-scale dispersal between such sites and the resulting assembly of thermophilic microbial communities. At these locations, geothermal heat flux forms islands of warmth and liquid water in an otherwise extremely cold and dry environment.

Our study has focused on Tramway Ridge (ASPA 130), a fumarolic field near the summit of Mt. Erebus, the southernmost active volcano on Earth. In order to better understand the composition, distribution and function of organisms within this community, we utilized amplicon and metagenomic sequencing of bulk environmental DNA. We found that surface-associated genetic signatures closely match signatures for thermophilic microbial mat taxa and mesophilic soil bacteria found widespread across Earth, whereas the subsurface is dominated by novel Archaea and members of poorly understood Bacterial candidate divisions that are closely related to those found in geothermal features at Yellowstone National Park (USA) and El Tatio Geyser Field (Chile).

These distributions imply that aeolian processes readily disperse viable organisms to Antarctica and that several subsurface-associated thermophilic lineages possess currently unknown adaptations that enable planet-wide dispersal. An ongoing metagenomic effort has resulted in the reconstruction of over 20 partial to nearly complete draft genomes, which are being used to elucidate the general mechanisms by which these particular organisms survive desiccation and UV exposure during aeolian transport between geothermal habitats

BIOINFORMATICS STUDIES FOR ANALYZING NGS-BASED MICROBIAL DIVERSITY DATA

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ABSTRACT

Microorganisms play critical roles in regulating the biogeochemistry of our planet. Microbial communities largely influence the relationships of biotic and abiotic environments. Assessing microbial diversity is the first step in understanding the role of microbes in biogeochemical evolution. Since a universal taxonomic structure of life based on ribosomal RNA (rRNA) was established in mid-1980s, ribosomal genes have been used as 'gold standard' to identify species and build higher-level taxonomies. Based on this taxonomical structure, the sequencing of rRNA genes (e.g., 16S in prokaryotes; 28S in eukaryotic microbes) derived from environmental samples led to the discovery of unprecedented diversity of both cultured and uncultured microbes. In addition, next generation sequencing (NGS) technologies such as pyrosequencing and Illumina are producing high-volume information at DNA level, facilitating the unprecedented detection of new phylotypes. However, the analysis of rRNA data generated from high-throughput sequencing experiments represents a bioinformatics challenge that requires accurate and efficient handling of large-scale data. We here describe our recent bioinformatics effort that includes developments of algorithm, software and database for NGS-based microbial diversity study.

BIODIVERSITY AND PRODUCTIVITY OF LICHENS ALONG A LATITUDINAL GRADIENT FROM TRANSANTARCTIC MOUNTAINS TO TIERRA DEL FUEGO

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ABSTRACT

In recent years a considerable research effort has being devoted to possible links between biodiversity richness, productivity, latitude and climate as a means to gain insights into the possible effects of future climate change. The Antarctic vegetation is also relatively simple, being composed of only bryophytes and lichens with the exception of the presence of two vascular plants in the Antarctic Peninsula. Major gradients exist for terrestrial vegetation biodiversity in Antarctica. First is the decline in species numbers with increasing latitude; second is the decrease in vegetation cover from almost complete in the South Shetland Islands, north-west of the Antarctic Peninsula, to sporadic patches along the Ross Sea coast to around 86°S; third is the change in growth rate that is almost two orders of magnitude higher in the Antarctic Peninsula than in the McMurdo Dry Valleys for lichens. An intensive survey carried on along the Transantarctic Mountains did not show the predicted gradual change in biodiversity but an unexpected pick at 84° S, apparently uncoupled with the decreasing temperature due to increasing latitude. Low temperature has traditionally been considered the most important factor influencing terrestrial vegetation, but water availability might be the main determinant for terrestrial biota in Antarctica, on the basis that the vegetation is mainly confined to microhabitats, which do not reflect the macroclimate. There is growing evidence supporting this view, and also that the relationship between macroclimate and vegetation performance may not be simple. The complexity occurs because the bryophytes and lichens that dominate the vegetation are both poikilohydric. This means that they are only active when hydrated, and this leads to two important consequences. First, the length of active time, and with it potential productivity, varies considerably within Antarctica; second, environmental conditions when the bryophytes and lichens are active can differ considerably from the macroclimate.

MOLECULAR RESPONSES OF THE ANTARCTIC VASCULAR PLANT *DESCHAMPSIA ANTARCTICA* TO ENVIRONMENTAL CHANGES

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ABSTRACT

Antarctic hairgrass (*Deschampsia antarctica* Desv.) is the only natural grass species in the maritime Antarctic. It has been researched as an important ecological marker and as an extremophile plant for studies on stress tolerance. Despite its importance, little genomic information is available for *D. antarctica*. Hence, we present the first *de novo* assembly of its transcriptome by massive parallel sequencing using *D. antarctica* plants grown under various environmental conditions. Total sequence reads generated by pyrosequencing were assembled into 60,765 unigenes, and 29,173 unique protein-coding genes were identified based on sequence similarities to known proteins. The combined results from all three environmental conditions indicated differential expression of 2,353 genes. As quantitative polymerase chain reaction showed that several genes were induced dramatically, they were subjected to functional research. Also, we report the complete chloroplast genome, transcriptome profiles of the coding/noncoding genes, and the posttranscriptional processing by RNA editing in the chloroplast system. The chloroplast genome of *D. antarctica* is 135,362 bp in length with a typical quadripartite structure. Sequence divergence analysis with other plastomes from the BEP clade of the grass family suggests a sister relationship between *D. antarctica*, *Festuca arundinacea* and *Lolium perenne* of the Poeae tribe, based on the whole plastome. In addition, we created an expression profile for 81 protein-coding genes and identified *ndhC, psbJ, rps19, psaJ*, and *psbA* as the most highly expressed chloroplast genes. We also found >30 RNA-editing sites in the *D. antarctica* chloroplast genome, with a dominance of C-to-U conversions. This dataset is the most comprehensive molecular resource currently available for Antarctic plant species and is therefore expected to contribute to a better understanding of the evolution of *D. antarctica* for use in molecular phylogenetic studies and may also help researchers understand the molecular responses of polar organisms to Antarctic environments.

POSTER SESSION

Antarctic Climate Records: Late Quaternary Ice Core and Geological Records

DISSOLUTION OF IRON AND MANGANESE OXIDES IN ICE AND ITS IMPACTS ON POLAR REGIONS

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ABSTRACT

Iron and manganese are one of the common elements in the Earth's crust and essential micronutrients for all kind of living organisms. The dissolution of iron and manganese oxides is important process to increase bio-availability and mobility of these elements. In this study, we investigated dissolution of iron and manganese oxides trapped in ice both in the presence and absence of light. The dissolution of iron and manganese oxides, which is very slow in water, significantly enhanced in ice phase in various experimental conditions. Outdoor experiments carried out under natural conditions in Arctic (Ny-Ålesund, Svalbard, 78° 55' N, 11° 56' E) and Antarctic (King George Island, 62° 13′ S 58° 47′ W) revealed that the dissolution of iron and manganese oxides was increased in ice phase. We speculated that the enhanced dissolution of iron and manganese oxides in ice is owing to freezing concentration effect (referring to exclusion and subsequent concentration of organic and inorganic solutes from ice crystals into liquid-like ice grain boundaries upon freezing) in ice grain boundaries. These findings imply that iron and manganese oxides particles might transformed to more bio-available forms when they trapped in icy environments (snow, glacier, ice-cloud particles, permafrost).

ENHANCED PRODUCTION OF ATMOSPHERIC IODINE IN ANTARCTICA

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ABSTRACT

Halogen compounds play a significant role in Earth's environments. Reactive halogens are involed in ozone depletion event both in Troposphere and Stratosphere, perturbation of HOx/NOx cycle, formation of cloud condensation nuclei(CCN), and mercury depletion event. Although the high concentration of atmospheric iodine compounds in the boundary layer of Antarctica was observed by ground-based and satellite borne observation, the mechanisms and sources are not well understood. In this work, the oxidation of iodide and subsequent release of atmospheric iodine both in the presence and absence of irradiation was investigated. The oxidation of iodide (I^-) to tri-iodide (I_3^-) and the following production of iodine molecule (I_2) were greatly enhanced in ice phase compared to those in aqueous solution. The outdoor experiments conducted under ambient environments of the Antarctic region (King George Island, 62°13′S 58°47′W, sea level) also sconfirmed the enhanced oxidation of iodide in ice phase. The freeze concentration of iodide, proton, and oxygen in ice grain boundaries is regareded as the major driving force for the enhanced oxidation of iodide and the following production of iodine molecule in atmosphere. These results suggest the unknown production pathway of the atmospheric iodine compounds in fronzen environments.

SPATIAL VARIATIONS OF PRIMARY, NEW AND REGENERATED PRODUCTION AFTER THE COLLAPSE OF THE LARSEN ICE SHELF, ANTARCTICA

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ABSTRACT

To better understand primary productivity in the Larsen A, B Ice Shelf areas of the Antarctica, the spatial dynamics of primary, new, and regenerated productivities (PP, NP, and RP) during 2012 NBP expedition of March–April 2012 were examined. After the breakup of Larsen B ice shelf, there has been the most dramatic changes in Larsen embayment. Stations were setup along the transect from within the ice sheet to the open ocean, and the rates of primary production and nitrogen uptake were determined in the water column using *in situ* ^{13}C and ^{15}N incubation techniques at 18 stations. The *f*-ratio is a measure of the proportion of new production to total production as defined by Dugdale and Goering (1967). It provides a means of estimating the upper limit of the carbon flux from the surface ocean and hence a measure of potential carbon drawdown from the atmosphere. The mean *f*-ratio was 0.87 of this study, the major nitrogen source would be NO_3. The mean integrates primary production was 422 mgC m^{-2} day^{-1}, ranging between 235 and 707 mgC m^{-2} day^{-1}. These data are discussed in the context of past studies in other areas of the Southern Ocean.

MILLENNIAL ATMOSPHERIC CO_2 CHANGE DURING THE EARLY HOLOCENE

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ABSTRACT

We obtained a new, precise and highly resolved atmospheric CO_2 record during the early Holocene (11.7–9.0 k.y.) from Siple Dome ice core, Antarctica. Combined with an existing Siple Dome CO_2 record for 9.0–7.3ka, a high-resolution CO_2 record for the early Holocene (11.7–7.3ka) is constructed to study CO_2 variations on millennial timescales. Our CO_2 record reveals that CO_2 slightly increased between 11.7 and 11.3 k.y. by 8.0 ppm and then decreased by ~9.9 ppm from 10.9 to 7.3 k.y. with local minima at 11.1, 10.1, 9.1 and 8.3 k.y. The CO_2 concentration strongly correlates with solar forcing on multi–centennial to millennial timescales. The millennial variability of CO_2 is also associated with records of ice rafted debris in the North Atlantic, the El Niño–like conditions in the eastern equatorial Pacific and sea ice extent in the Southern Ocean, which were possibly influenced by solar activity. We conclude that solar activity might have caused carbon cycle change in land and atmospheric CO_2 concentration.

HOLOCENE PALEOCLIMATE CHANGE IN THE ADÉLIE BASIN, EAST ANTARCTICA (IODP EXP. 318 SITE U1357)

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ABSTRACT

Core U1357A (about 186 m long) was drilled in the Adélie Basin near the Wilkes Land (East Antarctica) during IODP Expedition 318. Sediments of core U1357A are composed primarily of laminated diatom ooze. Based on 28 AMS radiocarbon dates of bulk sediments, the sedimentation rate of core U1357A was calculated to average about 1.7 cm/yr during the Holocene. Biogenic opal contents were measured at 10-cm intervals (*ca* 5-year resolution) using the wet-alkaline sequential extraction method. The raw data were binned to calculate 5-points mean in order to minimize the noise. Because the sediments of core U1357A mainly consist of annual lamination couplets and the analyzed sediments were sampled regularly regardless cm-scale layering, we have to assess the seasonal difference between the light and dark layers of the biogenic opal record representative of paleoproductivity. Based on the comparison with the new gray scale from shipboard photographs as well as the shipboard L* values, biogenic opal contents are independent of the lamination color. Comparison between XRF Si/Al ratios (at about 5-mm intervals) calculated by 21-point moving average and the biogenic opal contents shows a good correlation, indicating that the biogenic opal contents represent paleoproductivity associated with the paleoclimate changes in the Adélie Basin. After the deglacial termination at about 11 ka, the Adélie Basin became warm, and high productivity was maintained through the Hypsithermal interval. Productivity was reduced abruptly and distinctly at about 4-5 ka due to cooling, but resumed to increase at about 3 ka. Since then, late Holocene productivity decreased gradually toward the present.

A 50-YEAR RECORD OF LEAD ISOTOPES IN ANTARCTIC SNOW FROM DOME FUJI, EAST ANTARCTICA

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ABSTRACT

We report here the first record of Pb and Ba concentrations and Pb isotopic composition in snow from a remote site in central East Antarctica. The snow samples were recovered at a site close to Dome Fuji in Dronning Maud Land, East Antarctica (77°18´S, 39°47´E, 3785 m a.s.l.), on December 10, 2007, during the Japanese-Swedish IPY Antarctic expedition. Great precautions were taken during the collection of samples in the field to prevent the possibility of contaminating the snow. A continuous series of 80 snow samples were collected at a 5 cm depth interval from a 4-m deep snow pit, covering the period from 1956 to 2007.

The Pb and Ba concentrations and the isotopic composition of Pb were determined by means of thermal ionization mass spectrometry (TIMS). Our results show well-defined variations in Pb and Pb isotopic ratios, which is obviously linked to the rise and fall in the use of leaded gasoline in the Southern Hemislpere as previously reported from different locations in Antarctica. The changing Pb isotopic composition documents the predominent sources of anthropogenic Pb with time during the past 50 years. Pb concentrations remain at very low level with a mean concentration of 3.6 pg g^{-1} during recent years. Despite this low level of Pb, however, the isotopic signature reveals that significant input of anthropogenic Pb to central Antarctica is currently underway.

ATMOSPHERIC CO_2 CONCENTRATION CHANGE DURING THE LAST GLACIAL TERMINATION

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ABSTRACT

Ice cores in Antarctica and Greenland revealed that atmospheric CO_2 concentration is strongly correlated with climate during the past hundreds of thousands years (Luthi et al., 2008). However, exact CO_2 change mechanisms and phase relationship between the atmospheric CO_2 concentration and climate change are controversial (Brook, 2013). The last glacial termination is very interesting period because atmospheric CO_2 concentration increased by 80 ppm with deglacial warming (Monnin et al., 2001). Also, there were abrupt climate change events like Bølling-Allerød and Younger Dryas (Denton et al., 2010). A precise reconstruction of atmospheric CO_2 concentration during the last glacial termination may help us understand relationship between climate change and carbon cycle.

In this study we present a high resolution CO_2 record from Siple Dome ice core for the last glacial termination. The Siple Dome is located in West Antarctica (81°40'S, 148°50'W) and has a high accumulation rate of 12.4 g cm-2 yr-1 being suitable for reconstruction of a high-resolution CO_2 record (Ahn et al., 2012a;2012b).

Our preliminary results show several features: 1) atmospheric CO_2 concentration started to increase at 17.3 ka and experienced rapid increases of ~10 ppm at 16.0, 14.7, and 11.7 ka on GICC05 (Greenland Ice Core Chronology 2005) time scale. 2) The rapid increases at 14.7 and 11.7 ka are synchronous with or slightly lag after rapid CH_4 increases and abrupt warmings at the onset of Bølling-Allerød and end of Younger Dryas events. Those two CO_2 increases also occurred when the derivative of δ18Oatm changed from positive to negative sign, indicating that the rapid CO_2 increases are associated with the melting of ice sheets and change of biogeochemical processes in the low latitude (Severinghaus et al., 2009). 3) In contrast, the increase at 16.0 ka is different from the others in that the associated CH_4 and δ18Oatm changes are not as distinct as those during the other rapid CO_2 increases. More detailed analysis will be discussed.

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RECONSTRUCTION OF PALEO SEA SURFACE TEMPERATURE IN ANTARCTIC SEDIMENTS: APPLICATION OF NEW POTENTIAL PROXY (OH-TEX86)

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ABSTRACT

Isoprenoid glycerol dialkyl glycerol tetraethers (isoGDGTs) were produced by Crenarchaeota which is dominant in water column of ocean environment. The number of cyclopentane ring of isoGDGT is affected by environmental setting, especially sea surface temperature (SST). TEX_{86} (tetraether index of tetraethers consisting of 86 carbons) suggested by Schouten *et al*. (2002) is determined by isoGDGTs. TEX_{86} is applicable as the paleothermometer in the various environmental setting, such as open ocean, polar region and lacustrine. However, TEX_{86} reveal the low correlation in cold water environmets under the 5℃. To make up this weakness, Kim *et al*. (2010) sugessted a new paleo-temperature proxy for cold region, named TEX^{L}_{86}. Furthermore, the hydroxylated GDGTs have been ubiquitously observed in marine sediments (Liu *et al*., 2012). There is a correlation between the changes in the water temperature and OH-GDGTs distribution (Hugeut *et al*., 2012). In this study, we attempt to reconstruct paleo SST using the new proxies, such as TEX^{L}_{86} and OH-TEX_{86}, from sediment core in Antarctic. BIT index in Antarctic showed lower values than 0.2 in all sections from the sediment core. It means that marine archaea is dominant GDGTs source in study area. It accounted for about 10-15% of total GDGTs indicating a high OH-GDGTs content over the core. The change patterns of reconstructed SST from TEX^{L}_{86} and OH-TEX_{86} were very similar. However, the estimated both seawater temperatures showed differences between both indexes. It maybe occurred by limited data of OH-GDGTs for calibration. In this study, we confirmed the possibility of reconstruction paleo-SST using the new potential index, OH-TEX_{86}, but it appears that regional calibration is required due to lack of database about distribution of OH-GDGTs in the world ocean.

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DESIGN, PERFORMANCE TESTS AND APPLICATION OF MELTERING SYSTEM TO DECONTAMINATE SHALLOW FIRN CORES

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ABSTRACT

The meltering system of ice core samples has been a useful decontamination device. However, it should be very cautious to remove some pollutants in the outer surface of firn cores with typical meltering system due to perfocation effect of melted samples. In this study, as a major improvement, the melting head of the meltering system was constructed with Teflon (FEP) coated Cu divided into 2 zones due to the physical characteristics of firn core and performance tests such as decontamination efficiency and procedural blanks were systematically conducted with the artificial ice core samples (a cross section of ~3.2 cm×~3.2 cm, ~10 cm long). Quality of the measurement data was confirmed by analyzing a certified reference material (SRM 1643e for elements) and our data agreed well with the certified values. The results indicated that the cleanity of meltering system made up of the melting head, the connection tubes, and the sample collection bottles was very important factor in order to decrease the procedural detection limits (PDLs). Ice core samples were efficiently decontaminated by the meltering system, which was verified by the concentration profiles of melted samples from 2 zones of melting head. Especially, procedural blank tests indicated that the concentrations of elements in melted samples from inner zone of melting head were very comparable with those of elements in system blanks except for some elements such as ^{66}Zn and ^{63}Cu. The meltering system was rinsed with 0.1% HNO_3 (~total 10 mL) in order to remove memory effects of elements between firn core samples melted in series. The intercomparisons with conventional mechanical scraping method with stainless steel knives were also conducted. Finally, this technique was applied for the measurement of elements in firn core samples drilled at the NEEM site located at the north-western part in Greenland (77.45° N, 51.06° W, surface elevation 2450 m, mean annual temperature -29℃, accumulation 0.22 m ice equivalent per year).

PROKARYOTIC COMMUNITY STRUCTURE AND DIVERSITY IN A SEDIMENT CORE OF THE LARSEN C AREA IN THE WEDDEL SEA

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ABSTRACT

Detailed sedimentological and organic-geochemical studies of marine sediments along with microbial diversity can yield important information on paleoenvironmental changes. A sediment core (EAP13-GC16B), taken from the Larsen C area in the Weddel Sea during the Araon cruise in 2013, is being investigated to establish a precise chronostratigraphy using multi-proxies for reconstruction of sedimentary history and paleoenvironmental changes in the ice shelf system of the eastern Antarctic Peninsula. Here, in a parallel study, we made an attempt to find if the change in prokaryotic (i.e. bacterial and archaeal) communities could be used a proxy for drastic alterations in sedimentation conditions. Environmental genomic DNAs were successfully extracted from 59 horizons in the 240-cm long sediment core, yielding 283 to 663 ng DNA per gram wet weight. For 38 sediment horizons showing the success of polymerase chain reaction amplification of the 16S rRNA gene, prokaryotic populations were profiled by 454 pyrosequencing. In the poster presentation, results of prokaryotic community structure will be provided for the first time in the Larsen C sediment. In addition, co-occurrence of phylotype groups putatively linked to benthic ecosystem processes and biogeography in phylotypes of interest will be discussed.

**This work was supported by a grant of KOPRI (PP14010).

SPECTRAL ANALYSIS OF CYCLOSTRATIGRAPHY IN THE HOLOCENE GLACIOGENIC RHYTHMITES, LARSEN C EMBAYMENT, WEST ANTARCTICA

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ABSTRACT

We collected sediment cores from western and eastern Antarctic Peninsula, West Antarctica during 2013 KOPRI expedition. The sediment cores recovered glacial and Holocene marine sedimentary sequences. In particular, one sediment core obtained from Larcen C embayment was distinct in stratigraphic sequence compared to the previous results from Larcen A and B cores. Three distinct stratigraphic intervals (unit 3, 2 and 1) are recognized: a lower diamicton (unit 3; glacial), a laminated silty mud (unit 2; sub-ice shelf), and a bioturbated and ice rafted mud (unit 1; open marine condition). The laminated mud or "rhythmites" consist of from fine to coarse stratified mud and silt/mud alternations forming lithological pairs or couplets with some regularity. We investigate the depositional time scale of the lithological couplets and resolve the fundamental issue of time scale for these rhythmites during the Holocene. Episodic and even abrupt climate changes during the Holocene reflect a highly nonlinear interplay. Multiple proxies of marine core sediments have indicated time-scale variability for these changes. We will decide on the precise timing of the couplets (annual or decadal-centennial) and identify the periodicities of the couplet variations. During the Holocene, spectral analysis and tuning of high-resolution gray scale scans of sediment core cyclostratigraphy will reveal the critical key to resolve the secret of distinctive outcrops of paleo-laminated rocks discovered during ice ages through the geological time.

HYDROGRAPHY OF MARIAN COVE, KING GEORGE ISLAND, WEST ANTARCTICA: IMPLICATIONS FOR ICE-PROXIMAL SEDIMENTATION DURING AUSTRAL SUMMER

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ABSTRACT

During austral summers from 1996 to 2000, vertical profiles of conductivity, temperature, and transmissivity were obtained near the tidewater glacier of Marian Cove, King George Island, Antarctic Peninsula, to determine the short-term variations of water structure due to hydrographic forcings and to understand sedimentation of suspended particulate matter in Antarctic fjord environments. Four distinct water layers were recognized in the ice-proximal zone of the cove: 1) a surface layer composed of cold and turbid meltwater, 2) a relatively warm Maxwell Bay inflow layer with characteristics of outer fjord water, 3) a turbid/cold mid-depth layer (40 to 70 m water depth) originating from subglacial discharge, and 4) a deep layer comprised of the remnant winter water. The main factor influencing the characteristics of glacial meltwater layers and driving deposition of suspended particles in the cove is tidal forcing coupled with wind stress. The relatively small amount of meltwater discharge in Marian Cove yield low accumulation rates of non-biogenic sedimentary particles in the cove. A northwestern and western wind effects coupled with flood tide may promote settling and sedimentation of suspended particles from turbid layers in the ice-proximal zone of the cove.

POSTER SESSION

The Amundsen Sea as a Window to View the Future of the Antarctic in a Changing Global Climate

BIOCHEMICAL COMPOSITIONS OF PARTICULATE ORGANIC MATTER IN THE AMUNDSEN SEA, ANTARCTIC

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ABSTRACT

Biochemical compositions (proteins, carbohydrates, and lipids) of particulate organic matter (POM) including phytoplankton was investigated in relation to light and ambient major inorganic nutrients in the Amundsen Sea, Antarctic. Change of these compositions was assessed using colorimetric techniques, for irradiance response collected at 100, 30, and 1 % light penetration depth. The major inorganic nutrients were generally replete within 100 m depth. The average chlorophyll a (chl-a) concentration was 49.2 mg m^{-2} (S.D. = ± 27.6 mg m^{-2}) in this study. Large phytoplankton (> 20 μm) accounted for 64.1 % of total chl-a concentration. The response of biochemical fractions of POM to the light depths was not different significantly, which suggesting that POM was homogeneous distribution within the euphotic zone. The overall average compositions of proteins, carbohydrates, and lipids were 65.9 % (S.D. = ± 12.5 %), 22.4 % (S.D. = ± 10.9 %), and 11.7 % (S.D. = ± 6.5 %) for POM, respectively. The overall average calorific content of food material (FM) was 219.4 μg L^{-1} (S.D. = ± 151.1 μg L^{-1}) which were converted into 1.2 Kcal m^{-3} (S.D. = ± 0.8 Kcal m^{-3}). Along with other evidence (ratio of proteins:carbohydrates), high protein and low lipid compositions of POM in this study suggests that phytoplankton might not be a major inorganic nutrient limitation in the Amundsen Sea during the cruise period, 2012.

PARTICULATE ORGANIC CARBON CYCLING ON THE AMUNDSEN SHELF

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ABSTRACT

Various particulate organic carbon (POC) samples were collected including sinking POC, suspended POC in surface water, and sediment on the Amundsen Shelf, Antarctica, during the 2012 cruise on the IBRV Araon, and by an instrument mooring. Sinking particles were intercepted at 425m depth by a sediment trap from January 2011 for a year, near the periphery of the Amundsen Sea polynya. Sinking POC flux reflected primary production at surface. The radiocarbon values (as in $\Delta^{14}C$) were close to the values obtained for suspended POC at surface during the cruise in summer and remained so for a few months after sea ice was recovered. In Oct. Nov. and Dec., the $\Delta^{14}C$ values decreased, closely connected to increasing content of non-biogenic component in the sinking particles. Temporal variation in $\Delta^{14}C$ values of sinking POC will be discussed in association with the relative importance of freshly produced POC and resuspended sediment. Also, the $\Delta^{14}C$ values of sediments at 4 locations on the shelf will be discussed in terms of the organic matter sources and sediment accumulation rate.

ESTIMATION OF POC EXPORT FLUXES USING $^{234}Th/^{238}U$ DISEQUILIBRIA IN THE AMUNDSEN SEA, ANTARCTICA: PRELIMINARY RESULT

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ABSTRACT

In order to understand the carbon cycle in the Amundsen Sea of the Southern Ocean, the export fluxes of particulate organic carbon from the euphotic zone to depth were estimated using $^{234}Th/^{238}U$ disequilibrium method. Seawaters in 14 water columns were collected during February and March 2012, and analyzed for total and dissolved ^{234}Th, and particulate organic carbon.
Total ^{234}Th activities in the water column showed deficiency and excess relative to those of ^{238}U depending on the water depth. Deficiency of total ^{234}Th in the euphotic zone showed mirror images both with chlorophyll-a and fluorescence, and was consistent with the loss of nitrate, which indicated the effect of biological activity. In addition, deficiency of total ^{234}Th from deep water was associated with the increase of total dissolvable Fe/Mn concentration. Excess total ^{234}Th activity presented below the euphotic zone might be related to particulate ^{234}Th concentrated in this water depth.
Mean export flux of ^{234}Th estimated using the steady state model was 867 ± 246 dpm m^{-2} day^{-1}. Mean export flux of particulate organic carbon, which were estimated by the product of total ^{234}Th flux and ratio of $POC/^{234}Th$ (7.08 ± 4.27 μmol C dpm^{-1}) in the sinking particles, was 5.9 ± 3.9 mmol C m^{-2} day^{-1}. These fluxes were similar levels to those in the Weddell Sea during February and March 2008. Export ratios (ThE) relative to the primary production in the euphotic zone were in the range of 3-54 % (av. 28 %).

SPATIAL DISTRIBUTION OF MYCOSPORINE-LIKE AMINO ACIDS IN THE SOUTHERN OCEAN – CURIZE OF RV POLARSTERN (ANT XXVI/2)

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ABSTRACT

We measured the UV-absorbing compounds (mycosporine like amino acids; MAAs) of suspended particulate organic matter (POM) from punaarenas in Chile to wellington in New Zealand using RV Polarstern (27 November 2009 ~ 27 January 2010). Samples for the distribution of MAAs and pigment composition were collected under 10 m depth during the cruise. UV radiation increased from August to November by Ozone hole expended in the Southern Ocean (http://oonewatch.gsfc.nasa.gov/). The chlorophyll a concentration showed the highest value 0.99 μg/L at low seawater temperate and lowest value 0.06 μg/L at higher seawater temperate region. The MAAs concentration presented the highest value 163.6 μmol/ μg chl a and the lowest value 5.2 μmol/ μg chl a. The highest value of MAAs concentration showed in the higher seawater temperate region then low seawater temperate. The spatial distribution of total MAAs concentration had similar patten the individual MAAs such as shinorine, palthine, and mycosporine-glycine, with lower value of concentration in the western region from longitude 130 ˚W. However, In contrast porphyra-334 displayed a wide distribution in all region. The different pattern of individual MAAs and total MAAs concentration were through a specific characteristic of phytoplankton communities in the Southern Ocean.

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EFFECTS OF WIND AND SEA ICE ON THE SEASONAL VARIATION OF WARM CIRCUMPOLAR DEEP WATER IN THE AMUNDSEN SEA

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ABSTRACT

Spatial and temporal variation of the layer of warm and salty circumpolar deep water (CDW) in the center of the Amundsen Shelf was measured during two oceanographic surveys and a two-year mooring array. A hydrographic transect from the deep ocean, across the shelf break, and into the Dotson Trough shows a local elevation of the warm deep water layer at the shelf break. In the deep channel, the thickness of the CDW's warm layer varies strongly with season, attaining maximum thickness in austral summer and waning to a minimum in austral winter. The amplitude of this seasonal variation of the interface is up to 60 m. The seasonal variation in thickness of this warm layer gives rise to a seasonal variation of the CDW's heat content. To investigate the effects of wind and sea ice on the seasonal variation of the heat content, a simplified ocean surface stress model was used. Fields of Ekman pumping velocity were obtained from the ocean surface stress. The Ekman pumping at the shelf break, where the warm layer is elevated, shows a strong seasonal variation coinciding with the mooring data. From February to April, the marginal ice zone is close to the shelf break, and the wind field is eastward, giving rise to a strong positive Ekman pumping that may explain the seasonal signal seen in the mooring data. During austral winter, the marginal ice zone is further north, so the Ekman pumping does not cause any flow of warm water onto the shelf.

VARIABILITY IN SATELLITE-DRIVEN CHLOROPHYLL ASSOCIATED WITH EL NIÑ O-SOUTHERN OSCILLATION IN THE SOUTHERN OCEAN

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ABSTRACT

Satellite ocean color data from the Sea-viewing Wide Field-of-view Sensor (SeaWiFS) and Moderate-Resolution Imaging Spectroradiometer (MODIS) were used to examine the interannual variability of summer chlorophyll concentration in the Southern Ocean (south of 30°S) for the period between 1998 and 2012. To achieve consistency in the chlorophyll concentration between SeaWiFS and MODIS, we used an improved standard chlorophyll algorithm (OC v6). The averaged chlorophyll concentration in the Southern Ocean shows a persistent increasing trend of about 5.4% for the past 16 years with interannual fluctuations. On the assumption that interannual variability is affiliated with equatorial buoyancy forcing, El Niño and Southern Oscillation (ENSO), we analysed composite and regressed fields. Composite fields El Niño and La Niña months, in consistence with the regression analysis, show a spatially opposite relationship (r = -0.55) with very localized patterns. During El Niño months, chlorophyll concentration tends to increase in the South Pacific, while decrease over the Enderby and Argentine abyssal plains. Based on the R-square between observed and regressed fields, ENSO contributes about 3.5% of total variance in an area-averaged frame. The observed relationship points to the important influences of the teleconnected ENSO on the Southern Ocean chlorophyll.

SIGNIFICANT INFLUENCE OF GLACIER MELTING ON THE LEVEL OF TRACE ELEMENTS IN COASTAL SEAWATER OFF ANTARCTICA

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ABSTRACT

To evaluate the impact of modern glacier melting on the level of chemical enrichment in Antarctic coastal waters, we measured trace elements including dissolved iron (Fe) and rare earth elements (REEs), together with dissolved inorganic nitrogen (DIN), phosphorous (DIP), silicate (DSi), and dissolved organic carbon (DOC) in ice, snow, and coastal seawater of Marian Cove at the northernmost part of Antarctica (62°S). The concentrations of Fe and other trace elements (Al, Mn, Cr, Zn, Co, and Pb) increased from the bay mouth to the glacier valleys. This trend was mainly due to the influence of glacier melt water (GMW) as there were good correlations between salinity and these chemical species. When the effect of GMW was quantified based on plots for the presence of GMW (average 5.7%) in the surface water of the cove, GMW was found to have increased the concentrations of trace elements in seawater by 18 fold for Fe, 8 – 10 fold for Al and Mn, and 1 – 4 fold for Cr, Zn, Co, Pb, and REEs. However, the contributions of GMW to inorganic nutrients and DOC were negligible. The significance of REE contribution in this cove was further evidenced by middle REE (MREE) enrichment in cove water. Our results suggest that increased modern glacier melting in Antarctica has a significant influence on the level of trace elements, particularly for Fe, in cove water, which in turn may have a significant impact on the biogeochemistry of coastal seawater in Antarctica.

SATELLITE-DERIVED OPTICAL ABSORPTION PROPERTIES IN THE NEW ZEALAND SECTOR OF THE SOUTHERN OCEAN DURING AUSTRAL SUMMER OF 2014

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ABSTRACT

The Southern Ocean contributes significantly to global primary production and satellite remote sensing provides several advantages in assessing primary production in the region. Although chlorophyll based primary production models have been routinely used in many oceanic environments, they have been found deficient in the Southern Ocean. As such alternate absorption based models have been developed with promising results to estimate primary production from remote sensing. To obtain a better understanding of the optical environment in the New Zealand sector of the Southern Ocean, optical absorption of phytoplankton and detrital plus colored dissolved organic matter or CDM were examined during the Austral summer of 2014 using the Moderate resolution Imaging Spectroradiometer (MODIS) ocean color satellite data and the quasi-analytical algorithm (QAA). The satellite study is conducted in the context of field bio-optical measurements made onboard the R/V Araon as it transected the Southern Ocean from New Zealand to Terra Nova Bay in the Ross Sea, Antarctica during the 2014 Austral summer. In this study, the mean spatial distribution of satellite derived phytoplankton and CDM absorption during the summer as well as its temporal trends will be examined in relation to various water masses along the Araon transect. This work is supported by the Korea Polar Research Institute.

HETEROTROPHIC BACTERIAL BIOMASS AND PRODUCTION DURING LATE PHYTOPLANKTON BLOOM IN THE AMUNDSEN SEA POLYNYA, ANTARCTICA

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ABSTRACT

We investigated bacterial abundance and production and its coupling to phytoplankton in the polynya, sea-ice zon (SIZ) in the outer shelf, ice-shelf and offshore of the Amundsen Sea during late phytoplankton bloom by *Phaeocystis antarctica*. Overall oceanographic parameters indicated that the center of the polynya was characterized by higher surface temperature and strong stratification resulting from salinity gradient at 35 m depth, which should be responsible for the enhanced phytoplankton biomass. Chl-a concentration exhibited higher through the polynya stations, ranging from 2.93 to 6.30 $\mu g\ l^{-1}$ within the surface mixed layer, than that of the outer shelf (2.26 – 3.39 $\mu g\ l^{-1}$), ice shelf (0.65 – 1.67 $\mu g\ l^{-1}$) and off shore site (0.85 – 0.88 $\mu g\ l^{-1}$). Similarly, bacterial abundance and carbon production exhibited highest at the polynya (4.77×10^8 – 11.83×10^8 cells l^{-1}; 0.35 – 0.74 mmol C $m^{-3}\ d^{-1}$) than at the outer shelf (1.44×10^8 – 3.47×10^8 cells l^{-1}; 0.04 – 0.30 mmol C $m^{-3}\ d^{-1}$), ice shelf (1.64×10^8 – 5.36×10^8 cells l^{-1}; 0.09 – 0.42 mmol C $m^{-3}\ d^{-1}$) and off shore site (0.37×10^8 – 0.60×10^8 cells l^{-1}; 0.02 – 0.03 mmol C $m^{-3}\ d^{-1}$).

When bacterial abundance (BA) and production (BP) in the Amundsen Sea polynya was pooled, a significant linear regression was obtained with the spatial distribution of Chl-a (BA = 1.31 Chl-a + 0.71, r2 = 0.6957, $p < 0.0001$, n = 58; BP = 2.66 Chl-a + 0.15, $r^2 = 0.8378$, $p < 0.0001$, n = 59). Bacterial production exhibited a significant linear regression with the cDOM in the surface water column (BP = 41.26 cDOM – 1.289, $r^2 = 0.6832$, $p < 0.0001$, n = 17) as well. The BP/PP was higher at the center of the polynya (44.15 ± 7.14%) than at the SIZ (32.75 ± 17.75%) and at the ice shelf (37.4 ± 2.8%). Together with the positive relationship between Chl-a and BA and BP, the high BP/PP ratio strongly indicated that bacerial parameters were tightly coupled to the DOC supplied from the phytoplankton. Surprisingly, bacterial carbon demand (BCD) in the center of the polynya was higher than the carbon produced by primary production by a factor of 8 and 18 when BGE of 0.14 and 0.06 was adopted, respectively. The results indicated that most organic carbon produced by phytoplankton would be respired before sinking to the sediment. Additional analyses on the export flux, benthic mimeralizaiton together with the sources and flux of DOC that should satisfy the bacterial carbon demand in the Amundsen Sea polynya should be conducted.

SPATIAL PATTERNS IN PELAGIC CILIATE COMMUNITY RESPONSES TO VARIOUS HABITATS IN THE AMUNDSEN SEA (ANTARCTICA)

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ABSTRACT

In most pelagic ecosystems, planktonic ciliates can form a substantial proportion of microplankton and play a crucial role in the functioning of the pelagic food web. With their rapid growth and delicate external membranes, ciliates react more quickly to environmental changes than most other eukaryotic organisms. Previous studies have found strong relationships between ciliates and environmental conditions and hypothesized that the taxonomic composition of pelagic ciliates follows the environmental status of the water mass rather than a traditional zoogeographic distribution pattern.
In recent years climate induced change such as a reduction in sea ice extent and duration, increasing sea temperatures, and ocean acidification have been recognised as additional pressures on the Antarctic marine ecosystem and particularly microzooplankton abundance and distribution. To investigate the impacts of climate change on environmental conditions and pelagic biodiversity, spatial patterns in pelagic ciliate communities were studied at 18 stations from five habitats in the Amundsen Sea (western Antarctic) during austral summer from December 2010 to January 2011. Clear spatial patterns were observed in community structure, and significant differences were found among the various habitats. The species number, abundance, biomass, dominant species (12 aloricate species), and biodiversity indices (Shannon diversity *H'*, Pielou's evenness *J'*, and Margalef richness *D*) also showed clear spatial trends. Pelagic ciliate community structure accurately reflected environmental variability. Alone or in combination, several primary environmental variables were found to affect community spatial patterns in specific habitats. Three biodiversity parameters showed strong relationships with spatial changes in chlorophyll *a* and might be better predictor in future Antarctic studies.
This study presents the first detailed description of spatial patterns in pelagic ciliate communities and their correlations with environmental variability in habitats in the Amundsen Sea during early austral summer. Our findings provide detailed and basic data on the composition, distribution, and variation of ciliate communities in the Amundsen Sea, especially in polynya, and will help answer important questions about polar ecosystems.

DIVERSITY AND ABUNDANCE OF FUNCTIONAL GENES ASSOCIATED WITH DENITRIFICATION AND ANAEROBIC AMMONIUM OXIDATION IN THE SEDIMENT OF THE AMUNDSEN SEA POLYNYA, ANTARCTICA

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ABSTRACT

Denitrification and anaerobic ammonium oxidation (ANAMMOX) are the two major N removal processes in marine sediment. We investigated the diversity and abundance of functional genes together with the rates of the two processes at the center of polynya (Stn 17) and outer shelf (Stn 38) in the edge of the sea-ice zone in the Amundsen Sea. Depth- integrated (0 – 20 cm) inventories of NH_4^+ in the pore-water of the polynya site (Stn 17, 5.1 mmol m^{-2}) were 6.4 times higher than that of non-polynya site (Stn 83, 0.8 mmol m^{-2}). In contrast, depth- integrated (0 – 20 cm) concentrations of the NO_x (NO_2^-+NO_3^-) in the pore-water were 3.6 times higher at non-polynya site (Stn 83, 5.4 mmol m^{-2}) than at polynya site (Stn 17, 1.5 mmol m^{-2}). Denitrification and anammox rates at the polynya (Stn 17) appeared 0.12 and 0.09 nmol N cm^{-3} h^{-1}, respectively, whereas those at the non-polynya site (Stn 83) were not detected. Maximum abundance of prokaryotes estimated from 16S rRNA gene copy number were 20.6 x10^7 and 8.1 x10^7copies cm^{-3} at Stn 17 and Stn 83, respectively. Composition of denitrifying bacteria obtained from an analysis of nitrite reductase gene (*nirS*) showed that most of the clones were affiliated with *Gammaproteobacteria* (46% and 41% at the Stn 17 and Stn 83, respectively) and *Alphaproteobacteria* (54% and 59% at the Stn 17 and Stn 83, respectively). The diversity of denitrifying bacteria using nitrous oxides reductase gene (*nosZ*) showed that most of the clones belonged to *Alphaproteobacteria* (92% and 69% at the Stn 17 and Stn 83, respectively) and *Gammaproteobacteria* (8% and 31% at the Stn 17 and Stn 83, respectively). Further analyses to elucidate abundance and diversity of the functional genes associated with denitrification (i.e., *nirS*, *nosZ* and *narG* gene) and ANAMMOX (i.e., *nirS*, *hh* and *hao* gene) are in progress.

RATES OF BENTHIC RESPIRATION AND NUTRIENT FLUX AT THE SEDIMENT-WATER INTERFACE IN THE POLYNYA OF THE AMUNDGEN SEA, ANTARCTICA

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ABSTRACT

Polynya is an open water area in ice-covered polar seas, which in turn implies that more solar radiation penetrates into the water column, and subsequently, results in enhanced water column production. The organic matter derived from water column primary production is degraded by microbial activities in the sediment. Thus, quantitative studies on benthic respiration are essential for assessing carbon and nutrient cycles at the sediment-water interface of the polynya. The objectives of this study are to investigate the impact of polynya on the pore water geochemistry, sulfate reduction rate (SRR), benthic respiration and nutrient flux in the Amundsen Sea, Antarctica.
Depth integrated (0-20 cm) NH_4^+ in pore water was 2-6 times higher at polynya [Stn. 17 and 10 (4.4-5.1 mmol m^{-2})] compared to that in the ice-shelf [Stn. 19 (2.5 mmol m^{-2})] and open sea [Stn. 83 (0.8 mmol m^{-2})]. Depth integrated (0-20 cm) NOx in pore water was 3 times higher at ice shelf [Stn. 19 (3.8 mmol m^{-2})] and open sea [Stn. 83 (5.4 mmol m^{-2})] compared to that at polynya [Stn. 17 and 10 (1.5 mmol m^{-2})]. Depth integrated (0-20 cm) SRR was twice higher at polynya [Stn. 17 and 10 (0.21-0.23 mmol m^{-2} d^{-1})] than at ice shelf [Stn. 19 (0.12 mmol m^{-2} d^{-1}) and open sea [Stn. 83 (0.12 mmol m^{-2} d^{-1}). Benthic respiration at polynya [Stn. 17 and 10 (2.4-3.1 mmol m^{-2} d^{-1})] was twice higher than that of ice shelf [Stn. 19 (1.6 mmol m^{-2} d^{-1})] and open sea [Stn. 83 (1.6 mmol m^{-2} d^{-1})]. Dissolved inorganic nitrogen flux at polynya [Stn. 17 and 10 (0.12-0.16 mmol m^{-2} d^{-1})] was 2-3 times higher than that of ice shelf [Stn. 19 (0.09 mmol m^{-2} d^{-1})] and open sea [Stn. 83 (0.05 mmol m^{-2} d^{-1})]. Dissolved inorganic phosphate flux at polynya [Stn. 17 and 10 (0.02 mmol m^{-2} d^{-1})] was 5-10 times higher than that of ice shelf [Stn. 19 (0.004 mmol m^{-2} d^{-1})] and open sea [Stn. 83 (0.002 mmol m^{-2} d^{-1})]. Most organic carbon exported to the sediment (1.7 mmol C m^{-2} d^{-1}) was mineralized in the surface sediment (2.1 mmol C m^{-2} d^{-1}) of the Amundgen Sea polynya, but the rate of benthic respiration is no more than 3% of net primary production in the water column (78 mmol C m^{-2} d^{-1}). The results implied that most organic matter produced by primary production is respired in the water column before reaching to the sediment, and thus sediment processes play a minor role in regeneration of carbon and nutrient in the Amundsen Sea polynya. The fate of organic matter in the water column need to be further elucidated to better understand the carbon and nutrient cycles in the Amundsen Sea.

SPATIAL AND TEMPORAL VARIATION OF NET COMMUNITY PRODUCTION IN THE PACIFIC SECTOR OF THE SOUTHERN OCEAN

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ABSTRACT

The Southern Ocean (SO) is known to be an important sink of carbon, taking up half of annual global ocean uptake of atmospheric CO_2. The absorbed CO_2 is transferred from the surface to the deep ocean by various physicochemical and biological processes. The latter, so called 'biological pump', converts dissolved inorganic carbon and nutrients into organic matter through primary production at surface layers and exports the organic matter to the deep ocean. The biological pump in the SO affects not only the biogeochemistry in the SO but also that in low latitude oceans in conjunction with the subduction of mode and intermediate waters in the SO. Despite its importance, observations on the biological pump in the SO are sparse in time and space. Recent development of equilibrator inlet mass spectrometer (EIMS) provides an opportunity to investigate net community production (NCP), a measure of biological pump, with high spatial resolution. We will present spatial and temporal variation of NCP in the Pacific Sector of the SO based on our four-year (2011-2014) underway observations using an EIMS on IBRV Araon.

ANALYSIS OF FUTURE SEA ICE VARIABILITY AND TRENDS OVER ANTARCTIC IN 21st CENTURY BASED ON IPCC CLIMATE CHANGE SCENARIOS

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ABSTRACT

In contrast to the decrease of Arctic sea ice coverage, sea ice cover in the Antarctic has gradually increased since the late 1970s. However, sea ice in Bellingshausen/ Amundsen Seas showed the opposite (negative) trends comparing other sections like Ross Sea and Indian Ocean (Parkinson and Cavalieri, 2012). Likewise, Antarctic sea ice had various trends regionally. So to analyze the regional future trends and related processes in Antarctic sea ice, we have used a high-resolution atmospheric global climate model with 40 km horizontal grid resolution based on the coarse IPCC climate model simulations. With this high resolution climate model may provide a regional information on the changes in antarctic sea ice extent as well as thickness in detail.

To demonstrate the capability of GME GCM to reproduce the past climate in detail the present-day climate has been simulated for the period of 1979-2009 with the use of the AMIP observed SST and Sea Ice Concentration. And the future climate until the end of 21st century has been simulated by adopting the SST simulated by 4 CMIP5 models for the two RCP scenarios (RCP 8.5 and RCP 4.5) in the IPCC AR5. In the comparison with observation (HadlSST), the model reproduced the monthly spatial distribution of Antarctic sea ice extent and monthly trends. Based on these results, we have analyzed the future change and trend of sea ice and related other variables (surface temperature, wind vector, etc.) based on RCP scenarios by 5 sections of Antarctic around the Amundsen Seas.

Reference

Parkinson C.L., and D. J. Cavalieri, 2012: Antarctic sea ice variability and trends, 1979-2010. The Cryosphere, 6, 871-880

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POSTER SESSION

Interactions between the Solid Earth, the Oceans and the Cryosphere in the Victoria Land-Ross Sea, Antarctica

CHARACTERISTIC ATMOSPHERE AND OCEAN INTERACTIONS IN THE COASTAL AND MARINE ENVIRONMENT INFERRED FROM INFRASOUND ARRAYS AT LÜ TZOW-HOLM BAY, EAST ANTARCTICA

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ABSTRACT

Characteristic features of infrasound waves observed at Antarctica reveal the physical interaction involving surface environmental variations in the continent and surrounding Southern Oceans. A single infrasound sensor has been continuously recorded since 2008 at Syowa Station (SYO; 39E, 69S), the Lützow-Holm Bay (LHB), East Antarctica. The continuously recording data clearly represent a contamination of the background oceanic signals (microbaroms) during whole seasons. In austral summer in 2013, several field stations by infrasound sensors are established along the coast of the LHB. Two infrasound arrays with different diameter size are installed at both SYO (by 100 m spacing triangle) and S16 area on continental ice sheet (by 1000 m spacing triangle). Besides these arrays, two isolated single stations are deployed at two outcrops in LHB. These newly established arrays clearly detected the propagating directions and frequency contents of the microbaroms from Southern Ocean. Microbaroms measurements are a useful tool for characterizing ocean wave climate, complementing other oceanographic and geophysical data in the Antarctic. Moreover, several kind of remarkable infrasound signals are demonstrated, such as regional earthquakes, together with a detection of the airburst shock waves generated from meteorite injection at the Russian Republic on 15 February 2013. Detail and continuous measurements of the infrasound waves in Antarctica could be a new proxy for monitoring a regional environmental change as well as temporal climate variations in high southern latitude.

RECENT AND PAST SEDIMENTARY DYNAMICS ON SLOPE AREA OF THE ROSS SEA: PRELIMINARY DATA

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ABSTRACT

We present the preliminary data on sediment cores and box cores collected during the KOPRI ANA03B cruise onboard the IBRV ARAON in the Ross Sea (Antarctica) in February 2013 through a joint project between Korea and Italy. Italian participation was supported by PNRA in the framework of the ROSSLOPE Project (Past and present sedimentary dynamic in the ROSS Sea: a multidisciplinary approach to study the continental SLOPE). The goal of this collaborative research was to document the geophysical and sedimentological data in the Central Basin located at the mouth of the Joides Basin. This region represents the main shelf of the Ross Sea carved by a major ice stream that drained the East Antarctic Ice Shelf (EAIS) during the last glacial expansion. The seismic data show the presence of several sediment drifts around the Iselin Bank edge at different water depths at the foot of the slope of the Central Basin. The sedimentary sequences preserved in the Central Basin could provide important information about the High Salinity Shelf Water (HSSW) dynamics and the EAIS extension during the Quaternary glacial and interglacial cycles. During the cruise, sub-bottom profiles and multibeam surveys were performed and a multichannel seismic line was acquired along with the collection of the three box cores and two gravity cores in the Central Basin. The preliminary data were obtained from a gravity core KI-13-C1 and box core KI-13-BC2 collected at a depth of about 1800 m. Radiographs, XRF data, and very detailed photographs were processed onboard using an I-TRAX core scanner. Magnetic susceptibility, grain-size and organic matter analyses, chemical analyses (ICP-AES) on selected sediment samples, micropaleontology (diatoms and foraminiferal assemblages) have been carried out in the Korean and Italian laboratories. Age control was performed using ^{14}C radiocarbon dating on organic matter matrix, paleomagnetic measurement and diatom biostratigraphy. The upper 2.5 m of the sediment core is characterized by normal polarity, with paleomagnetic inclination mostly oscillating around the steep values which are expected for the high-latitude sampling site. A transition to reverse polarity occurred between ca. 2.5 m and 2.7 m that is characterized by relative low

paleointensity. The lower part (below 3 m) of core seems to be somewhat more complicated with a shallow paleomagnetic inclination and possible change in the magnetic mineralogy. The general absence of calcareous foraminifera (planktic and benthic assemblages) in the sedimentary record indicates the strong effect of the chemical-physical properties of seawater (e.g. lowering of the Carbonate Compensation Depth, bottom water oxygenation). The preservation of biogenic carbonates detected only below 2 m can be related to the warm climatic condition and the occurrence of low salinity melt waters.

PALEO DEPOSITIONAL ENVIRONMENT IN THE OUTER SHELF AND SLOPE OF THE CENTRAL BASIN, ROSS SEA, ANTARCTICA FROM SEISMIC STRATIGRAPHY AND TOMOGRAPHY

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ABSTRACT

We present the interpretation of seismic stratigraphy and tomography that provide information on the paleo depositional environment in the outer shelf and slope of the Central Basin, Ross Sea, Antarctica. The reflection seismic data from Korean and Italian Antarctic research programs (K-PORT and PNRA/ROSSLOPE), integrated with all existing seismic data, available through the Antarctic Seismic Data Library System (SDLS), were processed to carry out seismic sequence mapping and travel-time inversion. Multichannel seismic data across the outer shelf and upper slope, KSL12-1, shows a relatively thick and well-preserved sedimentary sequence deposited above the Ross Sea Unconformity 4 (RSU-4, early-mid Miocene from correlation with site DSDP 273) at the mouth of paleo glacial trough. The sedimentary sequence is composed of several seismic sequences bound by erosional unconformities indicating the occurrence of grounding ice sheet up to the shelf edge. Isopach maps compiled by using the seismic grid in the study area show the variation of thickness and depocenter shift of each sequence. The result of seismic tomography of KSL12-1 shows p-wave velocity anomalies that suggest sediment compactions by grounding ice sheets in the shelf topset beds and possibly the occurrence of gas and fluid in the slope sediments.

** This research was a part of the project titled ″Korea-Polar Ocean in Rapid Transition (KOPRI, PM13020)″, funded by the Ministery of Oceans and Fisheries, Korea.

2D ACOUSTIC-ELASTIC COUPLED WAVEFORM INVERSION IN LAPLACE DOMAIN USING GRADIENT SCALING METHOD

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ABSTRACT

The Laplace domain waveform inversion has been known to provide a long wavelength velocity model even for field data, which may be because it employs the zero-frequency component of the damped wavefield and a well-behaved logarithmic objective function. However, its applications have been confined to 2D acoustic and elastic media. In this study, we develop acoustic-elastic coupled media considering the irregular interface for marine geology with a gradient scaling method. The Laplace-domain full waveform inversion for acoustic-elastic coupled media with irregular interface can supper from numerical artifacts at the seafloor interface. In this study, we develop a new algorithm, which can reduce the numerical artifacts by performing various numerical tests. By a heuristic approach, we find a gradient scaling method for the Laplace-domain waveform inversion in acoustic-elastic coupled media that can be used to study geological targets beneath the seafloor. This method scales the gradient direction using an accumulated gradient, which is generated by the accumulated sum of the square of the conventional gradient with respect to depth. It is designed to enhance the recovery of large anomalies and the bottoms of high-velocity structures and to attenuate artifacts related to the irregular seafloor interface. Especially, this algorithm can construct more accurate inversion results of density then conventional algorithm. To prove our inversion algorithm, we perform numerical tests using the synthetic SEG/EAGE salt model and field data. Numerical results demonstrate the validity of Laplace-domain waveform inversions using the new scaling method for acoustic-elastic coupled media. We also conduct frequency-domain waveform inversions using the Laplace-domain inversion results as initial models. Reverse time migration images and synthetic seismograms obtained from the inversion show that this method can be successfully used for field data.

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GEOCHEMICAL CHANGE OF CORE KI-13-C1 IN THE CENTRAL BASIN OF THE ROSS SEA (ANTARCTICA)

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ABSTRACT

Biogenic opal and $CaCO_3$ contents were measured for a 3.26-m long gravity core KI-13-C1 (71°52.0'S, 179°30.3'E, 2246 m water depth) collected during ANA03B Cruise in 2013 to reconstruct paleoenvironmental change in association with the stability of the East Antarctic Ice Sheet during the late Quaternary. Biogenic silica concentration was measured by wet-alkaline extraction method modified from DeMaster (1981) and the biogenic opal content was calculated by multiplying the biogenic silica concentration by 2.4 (Mortlock and Froelich, 1989). Total inorganic carbon was measured by UIC CO_2 Coulometer (Model CM5014), and $CaCO_3$ content was calculated by multiplying TIC content by 8.333. Biogenic opal content varies from 1.3% to 30.3% with an average of 11.9% and $CaCO_3$ content changes from 0.2% to 2.4% with an average of 0.8%. Biogenic opal and $CaCO_3$ contents are consistently low in the upper 2 m of the core, whereas both contents are high in the lower part. Such transition depth (at about 2.5 m) coincides with the change of magnetic polarity. An interval of increased biogenic opal and $CaCO_3$ contents is likely to indicate the paleoceanographic and paleoclimatic change toward the warm and more productive conditions in the Central Basin of the Ross Sea.

HIGH-RESOLUTION SEASONAL VARIATIONS OF CHEMICAL COMPOSITIONS IN RECENT SNOW ON STYX GLACIER PLATEAU, VICTORIA LAND, ANTARCTICA

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ABSTRACT

A continuous series of 120 snow samples from a 1.5-m snow pit was collected at a 2.5-cm interval at a site on the Styx Glacier Plateau (73° 54′ 11.1″S, 163° 46′ 53.2″E,), Victoria Land, Antarctica, during 2011/2012 austral summer season. Various chemical components ($\delta^{18}O$, δD, Na^+, K^+, Mg^{2+}, Ca^{2+}, NH_4^+, Cl^-, SO_4^{2-}, NO_3^-, $CH_3SO_3^-$, $CH_3CO_2^-$, HCO_2^-, Hg_T, and trace elements) were measured to understand short-term variations of these species in the coastal Antarctic atmosphere. The snow samples were dated by prominent seasonal variations in $\delta^{18}O$, δD, MSA and NO_3^- concentrations, showing that a 1.5-m deep snow pit covers the period from 2009 austral winter to 2012 austaral summer with a mean accumulation rate of 23 g H_2O cm^{-2} yr^{-1}.

We present here the first data on high-resolution variability of various chemical species in recent snow in a coastal area of Atnarctica. Our data show that there is a pronounced seasonal variation of chemical species with different patterns between species, which are related to the relative strength of contribution from natural (sea salt, marine biogenic activities and volcanoes) or anthropogenic sources during different short-term period. These results allow us to understand the transport pathways and input mechanisms for each species and provide a valuable information to be useful for investigation of long-term (decades to century scale periods) variations of various composition in snow and ice from a shallow ice core to be retrieved from the Styx Glacier Plateau.

CHANGES IN THE DRYGALSKI ICE TONGUE, ANTARCTICA OBSERVED FROM CONTINUOUS GPS MEASUREMENTS

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ABSTRACT

Velocity and thickness variations of the Drygalski Ice Tongue on the west side of the Ross S ea were analyzed from two AMIGOSs (Automated Meteorology-Ice/Indigenous species-Gepphy sics Observation System) and Landsat images. The continuous GPS measurements since early 2012 present the ice velocities of ~705 m/yr at KA1 (near the ice front) and ~697m/yr at K A2 (25 km upstream of KA1) site. The ice tongue is stably flowing with residual displaceme nts in the range of 5m. We found small motions related with the drag by wind force and irr egular transverse motion with several meters amplitude in August 2012 and January 2014. Ac cording to the analysis of past Landsat images, there was a big change of flow direction in 2007. The flow direction change may imply the variation of ocean circulation or sea ice near the ice tongue.

The elevation observed by GPS is gradually lowering for two years. The snow accumulation, firn compaction, dynamic deformation by strain, and basal melt affect the elevation of the sur face on which the AMIGOS was installed. We removed other effects except for basal melt us ing the accumulation rate observed from the continuous camera images of a stake on snow, t he strain rate determined from the velocities at two AMIGOSs, and the previous estimates of firn compaction. The basal melt rates beneath the KA1 and KA2 are about 3 m/yr and 2m/y respectively. The new basal melt estimates beneath the Drygalski Ice Tongue are significantly larger than the basal melt in a steady state (~0.76 m/yr). The accelerated basal melt is a quit e recent event because the ICESat elevation measurement from 2003 to 2009 does not show a significant thinning as our in-situ measurement.

PRELIMINARY STUDIES ON MELT INCLUSIONS AND VOLATILE ANALYSIS IN BASALTS RECOVERED FROM AUSTRALIAN-ANTARCTIC RIDGE

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ABSTRACT

Australian-Antarctic Ridge (AAR), located in the south of Tasmania, is extension of eastenmost Southeast Indian Ridge. In January 2013, Korea Polar Research Institute (KOPRI) dredged basaltic rocks from the axis and off-axis seamounts of the AAR using Icebreaker Araon. Collected rock samples contain fine subhedral or anhedral olivine, plagioclase, and pyroxene phenocrysts. Off-axis seamount basalts contain more olivine phenocrysts compared to axis basalts. Olivine phenocryst in the seamount basalt contains many melt inclusions. While some of the olivine contains "homogeneous" glassy melt inclusions, most of the melt inclusions were observed to be internally crystallized. We picked olivine grains containing glassy melt inclusions, and analyzed major elements. The qualitative EPMA spectrum of the melt inclusions show Al, Mg, Si, Ti, Cr, Fe, Ni element peaks. High Mg/Fe ratio of the host olivine suggests high crystallization temperature of the olivine in the basaltic magma.
Quantitative understanding of sulfur and halogen elements in igneous rocks in MOR might give a better insight into the volatile circulation in the Earth's mantle. Qualitative SIMS (Secondary Ion Mass Spectrometry) transient signals demonstrate that the Antarctic KR1 basalts contain sufficient sulfur and halogen elements to be determined. We synthesized homogeneous and halogen-rich basaltic glasses for external Standard Reference Material (SRM). Basalt powder was mixed with compounds such as KI, NaI, CaCl2, KCl, FeS2, CaF2, Fe3O4, LiBr to produce the halogen and sulfur-rich glass beads. Double polished glass beads were checked for its halogen and sulfur contents, and its homogeneity.

BATHYMETRIC AND MAGNETIC CHARACTERISTICS OF THE EASTERNMOST SEGMENT OF AUSTRALIAN-ANTARCTIC RIDGE, 156°-161°E

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ABSTRACT

From 2011 to 2013, Korea Polar Research Institute (KOPRI) conducted a series of geophysical and geochemical expeditions on the longest and easternmost segment of Australian-Antarctic Ridge, located at 61°-63°S, and 156°-161°E. This super-segment plays an important role in constraining the tectonics of the Antarctic plate. Using IBRV *ARAON*, the detailed bathymetric data and eleven total magnetic profiles were collected. The studied ridge has spread NNW-SSE direction and tends to be shallower to the west and deeper to the east. The western side of the ridge (156°-157.50°E) shows a broad axial high and a plenty of seamounts as an indicative of massive volcanism. Near the center of the ridge (158°-159°E), a seamount chain is formed stretching toward the south from the ridge. Also, the symmetric seafloor fabric is clearly observed at the eastern portion (158.50°-160°E) of the seamount chain. From the topographic change along the ridge axis, the western part of the ridge appears to have a sufficient magma supply. On the contrary, the eastern side of the ridge (160°-161°E) is characterized by axial valley and relatively deeper depth. Nevertheless, the observed total magnetic field anomalies exhibit symmetric patterns across the ridge axis. Although there have not been enough magnetic survey lines, the spreading rates of the ridge are estimated as the half-spreading rate of 32.8 mm/y and 34.5 mm/y for the western portion of the ridge and 38.5 mm/y for the eastern portion. The studied ridge can be categorized as an intermediate spreading ridge, confirming previous studies based on the spreading rate of global ridge system. Here we will present the preliminary results on bathymetric changes along the ridge axis and its relationship with melt supply distribution, and detailed magnetic properties of the super-segment constrained by the observed total field anomalies.

VARIABILITY OF DOUBLE FREQUENCY MICROSEISMS AND SEA ICE IN THE ROSS SEA, ANTARCTICA

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ABSTRACT

Korea Polar Research Institute has been operating a broadband seismic network in the Terra Nova Bay, Antarctica, since 2011. Examining ambient seismic noise level using power spectral analysis for the period of 2011-2013, we observed a seasonal pattern at 4-10 s period. The amplitude of double-frequency (DF) microseism reaches an annual minimum in July. Correlation of the DF energy and Sea-Ice Concentration (SIC) information obtained from the AMSR-E (Advanced Microwave Scanning Radiometer for EOS Aqua), we found a strong negative correlation. The result implies that as the SIC becomes higher, i.e. more sea-ice in the ocean, the DF power decreases, which is coincident with the hypothesis of 'sea-ice damping effect'. We also determined the lag time as almost zero from the cross correlation indicating that the DF energy responses immediately to the sea-ice condition nearby. In this study, we propose that a long-term observation of the DF microseisms should be necessary to monitor local climate change in Polar Regions, which contributes extra benefits to the satellite remote sensing.

INTEGRATED CRYOSPHERE MONITORING NETWORK IN THE VICTORIA LAND-ROSS SEA, ANTARCTICA

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ABSTRACT

The Polar Regions have been experiencing dramatic changes particulary including glacier retrieting, ice thining, declining in sea ice extent, and so on. Recent literatures illuminate that the melting rate of ice sheets and glaciers in the West Antarctic has accelerated, which may lead significant contributions to global sea level rise. Korea Polar Research Institute (KOPRI) has just launched second Antarctic research station, Jang Bogo station, at Terra Nova Bay in Nothern Victoria Land, Antarctica, which allows us to have unprecedented opportunity to continously monitor the change of cryospheric environment. In an attempt to understand the complex forms of interaction between the Solid Earth, the Oceans, the Atmosphere, and the Cryosphere, KOPRI has been operating integrated Cryosphere monitoring network over the Terra Nova Bay since 2011. The network is comprised of local broadband seismic stations, GPS stations, AMIGOS systems, Ocean Bottom Seismometers, and an Ocean Bottom Hydrophone. In addition to the ocean and land based observation, we perform satellite remote sensing and plan to conduct aerogeophysical surveys as well. In this symposium, we present the current status of our observational effort and its preliminary results.

DEPLOYMENT OF OCEAN BOTTOM SEISMOMETERS IN THE ROSS SEA, ANTARCTICA

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ABSTRACT

Although a number of active source seismic experiments have been conducted over the last few decades to investigate the crustal structure in the Ross Sea, long-term observation to monitor rapid changes in the Cryospheric environment still remains challenging due to existence of sea ice in the study region. Korea Polar Research Institute has accomplished the first successful deployment with four LOBSTER (Long-term OBS for Tsunami and Earthquake Research) systems collaborating with Alfred Wegener Institute during the period of 2011-2012 in the Terra Nova Bay. The LOBSTER system, manufactured by K.U.M., is equipped with one broadband seismometer (Trillium compact) and one acoustic pressure gauge. All sensors and peripherals are securely protected by titanium casings, which allow the system to be functioning in up to 6,000 m depth during the operation period. Completing preliminary analysis on the recovered data, we present detected cryogenic signals such as long duration tremors that might be associated with movements of the Drygalski Ice Tongue as well as typical tectonic events.

POSTER SESSION

Life of King George Island in the Changing Environment

STRUCTURAL AND CHEMICAL MODIFICATION OF Fe-RICH SMECTITE ASSOCIATED WITH MICROBIAL Fe-RESPIRATION IN KING GEORGE ISLAND, WEST ANTARCTICA

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ABSTRACT

Surface soil samples were collected from Antarctic exploration (2010/2011, 2011/2012) at Barton Peninsula, King George Island, West Antarctica to determine the feasible biological alteration of clay minerals in Antarctica where the physical weathering is considered to be a major process. Seven areas (1226-1, 1226-2, 0101-4, 0105-1, 0105-2, 0107-2, 0107-3) from the coast toward the inland were investigated. The duration of exposure of soil samples to the air depending on the retraction of ice to the inland may affect the microbial activity resulting in the biogeochemical mineral alteration. The multiline of techniques for example, X-ray diffraction (XRD), Scanning Electron Microscope (SEM), wet chemistry, and batch experiments of microbe-mineral interaction under the low temperature that mimics the Antarctic condition to understand the mechanism of biogeochemical alteration of clay minerals. Clay minerals of smectite, mica, chlorite and kaolinite were detected in the XRD profiles. The variation of relative amount of clay minerals in the regions indicated that the physical/biological alteration might be different depending on the duration of ice retraction. From the batch experiment using Nontronite, moreover, we confirm that Psychrophilic bacteria (Shewanella sp. isolated from King George Island) reduce structural Fe(III) of clay mineral, and occur structural change of smectite at low temperature (4℃ and 15℃). The study, therefore would present the feasibility of biological effects on chemical modification through the structural changes in clay mineral in cold environment.

COMPREHENSIVE SURVEY OF SOIL BACTERIAL COMMUNITY STRUCTURE IN BARTON AND WEAVER PENINSULA OF KING GEORGE ISLAND, ANTARCTICA

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ABSTRACT

Over the last few decades, terrestrial environments in Antarctica had been believed as sterilized habitats without any life forms because of the extreme environmental conditions. However, recent studies have started to report the unexpectedly high diversity of bacteria and their community structure is highly complex in these harsh environments. In this study, we investigated the bacterial community structure in soil samples collected from the Barton and Weaver Peninsula of King George Island. In total, 260 samples were taken from the upper (0-3 cm) and lower (3-10 cm) layer of soil during the period from December of 2010 to February of 2012. Bacterial community structure was analyzed by pyrosequencing targeting the V1-V3 region of 16S rRNA gene. Overall 409,863 sequence reads were obtained and 13,931 operational taxonomic units (OTUs) were generated when 97% similarity cutoff was used for OTU clustering. Actinobacteria (27.0%), Proteobacteria (19.3%), Acidobacteria (10.5%) and Chloroflexi (10.4%) were dominant across all habitats. Interestingly, candidate phylum AD3 (4.4%) was abundant in several soil samples, which has not been recognized in previous studies. Soil bacterial community structure was distinct to each habitat, paralleling to the spatial locality and physicochemical property of each habitat. Overall it appears that soil bacterial community is habitat-specific and varying chemistry of differing soil layers has a significant role in structuring bacterial communities in this environment.

COMPREHENSIVE ANALYSIS ON BACTERIAL BIODIVERSITY IN ICE-COVERED ANTARCTIC LAKES OF MCMURDO DRY VALLEYS

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ABSTRACT

The ice-covered lakes of the McMurdo Dry Valleys (MDVs) are widely acknowledged as one of the extreme habitats on Earth. Permanently cold temperatures in these aquatic ecosystems are considered one of the limiting factors for life. Despite environmental constraints, some dominant microorganisms have adapted to and thrive in these harsh-icy environments. To better understand the distribution and diversity of prokaryotes (bacteria), we conducted 454-sequencing of the 16S rRNA gene using 77 samples collected from five distinct lakes of the MDVs in November and December in 2012: Lake Fryxell (FRX), Lake Miers (MIE), Lake Hoare (HOR), West (WLB) and East (ELB) lobe of Lake Bonney. Total 2,339 operational taxonomic units (OTUs) were generated from approximately 2.3 million sequence reads with 97% similarity cutoff. Sequence reads were clustered into 57 phyla, and FRX was shown the most diverse habitat while ELB was the least diverse, with 656 OTUs and 162 OTUs, respectively. Also, *Bacteroidetes* (29.8%) and *Actibonacteria* (26.7%) was the most dominant phylum across all samples, and *Proteobacteria* (16.7%) was the next predominant phylum, especially dominating the *Betaproteobacteria* in FRX and *Gammaproteobacteria* in WLB. These support that the phylum level taxonomy presented highly heterogeneous bacterial communities among lake habitats. Results from this study demonstrate that community composition was most related to water column type with defined dominant OTU, and these stable lakes contain diverse bacterial communities. Furthermore, distinct microbial communities in each lake of MDVs provide important clues in predicting the impact of microbial ecological roles in these harsh ecosystems.

ROCK WEATHERING OF VOLCANICS BY LICHEN IN THE MARITIME ANTARCTIC

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ABSTRACT

Bedrocks and their fragments of Tertiary andesitic to basaltic lavas/tuffs and granodiorite are exposed around ice caps, King George Island, South Shetland Islands, Antarctica. The bedrocks and rock fragments were covered with rich vegetation of lichen. Microscopic examination of rock-lichen interfaces showed physical and chemical weathering by the lichen growth and metabolism. However, the degree of lichen-induced weathering was dependent upon both the lichen type and lithology. Fruticose lichens caused only the weak surface exfoliation of rock surfaces, while crustose lichens induced significant exfoliation and leaching of minerals. The crustose lichens penetrated into the microfissures and grew to widen the fissures. Volcanics were more susceptible to chemical weathering by lichens than granodiorite. Plagioclase, chlorite, and biotite in volicanics were preferentially weathered. Plagioclase was replaced by amorphous silica. Chlorite and biotite were either replaced by amorphous silica or congruently dissolved. Voids produced by mineral dissolution were subsequently penetrated by the lichens, inducing further exfoliation. Findings in this study showed that crustose lichens significantly enhanced the physical and chemical weathering of volcanics under maritime Antarctic terrestrial environments.

TEMPORAL VARIATION OF MICROALGAE AND ENVIRONMENTAL FACTORS IN THE SURFACE WATER OF MARIAN COVE, KING GEORGE ISLAND, ANTARCTICA, 2010

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ABSTRACT

As a research on the ecology of phytoplankton in the coastal waters of the King Sejong Station in Antarctica, the community of microalgae and the temporal influences of environmental factors were investigated in the Marian Cove, Maxwell Bay of King George Island in Antarctica. This investigation was conducted from Jan. 1, 2010 to Dec. 31, 2010 at a fixed point near the King Sejong Station. The community of microalgae and the concentration of chlorophyll a as biological factors and water temperature, salinity and nutrients as physiochemical factors were measured and their correlation with biological and environmental factors were analyzed.

Out of all the species of microalgae appearing in this study area, this study discovered a total of 73 species including, 2 species of dinoflagellates, 67 species of diatoms, 1 species of cryptophytes, 1 species of haptophytes, 1 species of silicoflagellates, and 1 species of prasinophytes.

The abundance of microalgae was counted as 9.56 X 10^5 cells L^{-1} on annual average, and it was lower in the wintertime, and they tended to increase during summertime. With the exclusion of pico-sized microalgae, haptophyte *Phaeocystis* sp., dominated in the area for most of the research period, while diatom *Thalassiosira* spp., below 10 ㎛ in size was dominant only in August. Pico-sized phytoplankton contributed large proportion to the total biomass of phytoplankton as a major group from fall to spring except summer and with the change of season from fall to winter, pico-sized phytoplankton made up the bulk.

According to the correlation analysis between microalgae and environmental factors, water temperature and total solar radiation were major influence on the distribution of phytoplankton .The seasonal distribution of phytoplankton was influenced by water temperature and air temperature in the spring, by nutrients in the summer, by water temperature and salinity in the fall, and by total solar radiation in the winter. Especially, this study confirmed that total solar radiation had positive correlation with all seasons except summer, and nutrients acted as more of a limiting factor rather than light during the summer season.

According to the comparative analysis on the data of phytoplankton and temperature in 1996 and 2010, although annual mean temperature in 2010 was lower than that in 1996, the total abundance of the microalgae was higher in 2010 than in 1996, which was caused by higher nutrients in 2010 than those in 1996, which in turn increased the abundance of microalgae.

It turned out that in 2010 in Marian Cove, Antarctica, the abundance of microalgae exhibited distinct seasonal change and changes in species composition of microalgae were seasonally affected by various environmental factors. The major conclusion of this study is that, among numerous environmental factors, water temperature and light exert plenty of effects on the growth and development of microalgae in Antarctica.

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LOBARSTIN ENHANCES CHEMOSENSITIVITY IN HUMAN GLIOBLASTOMA T98G CELLS

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ABSTRACT

Background/Aim
Lobarstin is a metabolite occurring from the Antarctic lichen *Stereocaulon alpinum*. Human glioblastoma is highly resistant to chemotherapy with temozolomide. Lobarstin was examined for its effect on glioblastoma.

Materials and Methods
Temozolomide-resistant T98G cells were subjected to toxicity test with temozolomide and/or lobarstin. DNA damage and recovery was assessed by alkaline comet assay and expression of DNA repair genes was examined by RT-PCR and western blot analysis.

Results
Lobarstin alone at 40 μm was toxic against T98G, but had no effect in primary human fibroblasts. Co-treatment of lobarstin with temozolomide yielded enhanced toxicity. Temozolomide-alone or with lobarstin co-treatment gave similar extent of DNA damage. However, the recovery was reduced in co-treated cells. Expression of DNA repair genes, O^6-methylguanine-DNA methyltransferase, poly (ADP-ribose) polymerase 1 and ligase 3 were reduced in lobarstin-treated cells. Conclusion: Our results suggest that enhanced sensitivity to temozolomide by lobarstin co-treatment may be attributed to reduced DNA repair.

LOBARSTIN INDUCES CELL DEATH IN ACUTE PROMYLOCYTIC LEUKEMIA NB4 CELLS

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ABSTRACT

Several lichen metabolites are known to harbor various biological activities including anti-biotic, anti-mycobacterial, anti-viral and anti-pyretic properties. Recently we have reported that lobarstin, a metabolite isolated from the Antarctic lichen *Stereocaulon alpinum,* acts as a potent anti-cancer agent in human glioblastoma cells (Kim et al., 2013). In the present study, we examined its possible anti-cancer effect in acute promylocytic leukemia (APL) cells. At 15 μM, lobarstin treatment resulted in reduced cell viability comparable to that of 1 μM arsenic trioxide (ATO) in NB4 cells, but showed no toxic effect in human normal fibroblast cells. Lobarstin or ATO alone induced growth inhibition of NB4 cells, but when treated together more growth inhibition was observed. Combination of lobarstin and ATO synergistically triggered cell death accompanied by accelerated caspases activation. Intriguingly, the amount of PML-RARA oncoprotein, which is a critical target in APL cancer therapy, was reduced upon lobarstin treatment. Enhanced expression of LC3, an autophagic marker, suggests autophagy as a possible molecular mechanism of PML-RARA deagradation. Taken together, our results open the possibility of lobarstin as an effective therapeutic candidate in APL.

Reference

KIM, S., JO, S., LEE, H., KIM, T. U., KIM, I. C., YIM, J. H. & CHUNG, H. 2013. Lobarstin enhances chemosensitivity in human glioblastoma T98G cells. *Anticancer Res,* 33**,** 5445-51.

HIGH-QUALITY DRAFT GENOME OF ALPHAPROTEOBACTERIAL STRAIN PAMC 27157, THE FIRST REPRESENTATIVE OF A NEW GENUS IN THE FAMILY *AURANTIMONADACEAE*

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ABSTRACT

Strain PAMC 27157 was isolated from a melting pond on Arctic sea-ice during the Araon cruise in summer 2012. The 16S rRNA gene sequence analysis revealed that strain PAMC 27157 belonged to the family *Aurantimonadaceae* with close relatives of the genera *Aureimonas* (94.0-96.2%), *Aurantimonas* (95.8-96.1%), *Martelella* (94.1%) and *Fulvimarina* (93.8%). Phylogenetic analyses of 16S rRNA gene sequences showed that strain PAMC 27157 was not associated with any known genus in the family *Aurantimonadaceae*. To find genomic features of the new isolate, whole genome sequencing by the Illumina Hi-Seq platform with two DNA libraries was attempted. The estimated genome size was 4,139,090 bp with the coverage of 456x. The draft genome was arranged into 22 scaffolds of 39 contigs containing 4,100 protein-coding genes and 53 RNA genes. Strain PAMC 27157 possessed predicted genes of ecological interest, such as choline and betaine uptake and betaine biosynthesis against osmotic stress, cold and heat shock proteins, DNA repair of UV damage, motility, multi-drug resistance and transposable elements. These genes might facilitate survival and growth of the strain for the period from sea-ice formation to melting pond formation when dramatic changes of environmental (e.g. salinity, temperature and solar irradiance) and biological parameters (e.g. interactions of micro-organisms by altered cell density) are expected in winter to summer seasons. Detailed genomics of strain PAMC 27157 will provide further insight into adaptation and persistence of Arctic sea-ice bacteria.

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PRODUCTION OF AN ICE BINDING PROTEIN FROM *FLAVOBACTERIUM FRIGORIS* PS1 BY FERMENTAION OF *PICHIA PASTORIS*

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ABSTRACT

To survive in sub-zero temperatures, polar organisms produce Ice Binding Proteins (IBPs) in internal organs. These IBPs prevent formation of large intracellular ice crystals, which have fatal effects on the organism. We have isolated FfIBP, the IBP from the Gram-negative bacterium *Flavobacterium frigoris* PS1 from the Antarctic sea ice. FfIBP was cloned and produced by recombinant *Pichia pastoris* by using fed-batch fermentation with methanol feeding for 120 h. The laboratory-scale (7-L) production of FfIBP was performed to optimize the culture conditions such as pH and temperature. The optimal temperature and pH were determined to be 30℃ and pH 5.0 for FfIBP production. The total amount of secreted protein was ~519 mg/L, 50% of which was FfIBP, yielding ~259 mg/L. The highest thermal hysteresis (TH) activity of FfIBP was about 1.7 ℃ from fermentaion sample at 120 h. These results provide key aspects associated with the large-scale production of an ice binding protein, FfIBP.

LACINUTRIX JANGBOGONENSIS, SP. NOV., A PSYCHROPHILIC BACTERIUM ISOLATED FROM MARINE SEDIMENT OF ANTARCTIC

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ABSTRACT

A taxonomic study was performed on strain PAMC 27137 ^{T} which was isolated from the marine sediment of the Ross Sea of the Southern Ocean, Antarctica. The novel strain was golden-yellow, aerobic, gram-negative, rod-shaped, non-motile, and psychrophilic. Growth temperature ranged from 4 to 10°C and the pH for growth ranged from 6.5 to 7.5. The optimum growth temperature and pH were 10°C and 7.0 respectively. The strain grew in the presence of 2.5-4% (w/v) sea salts. The predominant fatty acids (>5%) were iso-$C_{15:1}$ G (19.9%), iso-$C_{15:0}$ (19.3%), iso-$C_{17:0}$ 3-OH (11.3%), summed feature 9 (9.1%), iso-$C_{15:0}$ 3-OH (7.5%), and anteiso-$C_{15:1}$ A (5.8%). Strain PAMC 27137 ^{T} contained MK-6 as the major respiratory quinone. The polar lipids consisted of a phosphatidylethanolamine (PE), an unidentified aminolipid (AL1), an unidentified aminophospholipid (APL), and five unidentified phospholipids (L1 to L5). Phylogenetic analysis based on the 16S rRNA gene sequence indicated that strain PAMC 27137 belonged to the genus *Lacinutrix* and were closely related to *Lacinutrix mariniflava* JCM 13824^{T} and *Lacinutrix algicola* JCM 13825^{T} with 97.6% and 97.1% sequence similarities, respectively. The genomic relatedness between PAMC 27137^{T} and closely related strains was calculated using average nucleotide identity values of whole genome sequences, which indicated that the new isolate represents a novel genome species. Genome sequencing results revealed that strain PAMC 27137 represented a single species that was distinct from *L. mariniflava* JCM 13824^{T} and *L. algicola* JCM 13825^{T}. The genomic DNA G+C content of strain PAMC 27137 ^{T} was 33.5 mol%. Based on data from this polyphasic taxonomic study, strain PAMC 27137 ^{T} is considered to represent a novel species of the genus *Lacinutrix*, for which the name *Lacinutrix jangbogoensis* sp. nov. is proposed. The type strain is PAMC 27137 ^{T} (=KCTC 32573^{T} = JCM 19883^{T}).

MICROCLIMATE MONITORING AROUND LICHEN HABITAT IN BARTON PENINSULAR, KING GEORGE ISLAND, ANTARCTICA

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ABSTRACT

Lichens are widely distributed on earth including extreme environments such as tropic, desert, high alpine and polar areas. Lichens are major flora in the terrestrial ecosystem of the Antarctic and account for more than 70% of floral diversity in Antarctic terrestrial ecosystem. Their distribution patterns are very complex and look dependent on the microclimatic conditions, which in turn are dependent on the geomorphological features. We selected five long-term ecological research (LTER) sites to study environmental factors that affect floral distribution, responses of lichens, mosses, and microoragnisms to environmental changes. Major flora in these sites was *Sanionia, Polytrichastrum, Cladonia, Ochrolechia, Psoroma, Spharophorus*, and *Stereocaulon*. We monitored temperature, relative humidity, photosynthetically active radiation (PAR), temperature and water content of substrate from February 2013 to January 2014 to understand diversity of microclimate and effect on lichen distribution. Maximum PAR value in each LTER site was highly variable ranging from 1823.7 to 2338.7 μE. Maximum and minimum temperature records were 20℃ and -17℃ and they were variable with 8℃ and 4℃ differences depending on sites. We compared weather conditions for specific positions with different vegetation to examine if some of the microclimate factors can explain different distribution patterns of lichen species.

PHYSIOLOGICAL CHARACTERISTICS OF POLAR AND ALPINE BACTERIA ACCORDING TO THE TAXONOMY, HABITAT, AND GEOGRAPHICAL ORIGIN

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ABSTRACT

Polar and alpine areas may have harsh environments with low temperature and low nutrient concentration. Microorganisms in these areas survive and grow by their unique characteristics such as cold-adapted enzyme productions. Extracellular enzymes secreted by cold-adapted microorganisms may play important ecological roles in the cycling of organic matters. In this study we performed broad scale screening of the physiological characteristics such as temperature response and extracellular enzyme production of bacteria according the taxonomy, habitat, and geographical origin. Three hundred forty seven bacterial strains of Polar and Alpine Microbial Collection (PAMC) with various taxonomic information which were originated from a variety of habitats of polar areas were selected. Bacterial strains were included in Gammaproteobacteria (48.4%), Bacteroidetes (20.2%), Actinobacteria (13.5%), Alphaproteobacteria (7.5%), Firmicutes (6.1%), Betaproteobacteria (4.0%) and Deinococcus-Thermus (0.3%) and they were originated from biotic (lichen, moss, algae and animal) and abiotic (terrestrial soil, marine sediment, sea water, fresh water, cryoconite, debris, ice, snow and biofilm) samples of Arctic (Svalbard, Khuvsgul, Kara Sea, and Barents sea), Antarctic (Adelie Island, Barton Peninsula, King George Island, Weaver Peninsula), Innsbruck and Russia. Most strains grew ranging from 4℃ to 30℃ (optimal 10℃), while the number of strains could grow at higher than 30℃ decreased. The number of bacterial strains from biotic samples could better grow than that from abiotic samples. By phylum, strains included in Bacteroidetes, Gammaproteobacteria and Alphaproteobacteria were more psychrophilic than others. Bacteria from arctic were psychrophilic and strains from Innsbruck and Russia showed mesophilic patterns. One hundred thirteen strains showed hydrolytic enzymes activity. According to habitat, strains from algae, animal, biofilm, cryoconite, ice/snow, sea water and terrestrial soil had all extracellular enzyme (protease, lipase, cellulase) activities examined. Five strains from algae showed the highest activity of all enzymes. Eight strains from lichen/moss and cryoconite showed high protease activity and 24 strains from biofilm showed high cellulose activity. Bacteria from Innsbruck and Russia showed the highest enzymatic activity.

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POLAR AND ALPINE MICROBIAL COLLECTION (PAMC): A CULTURE COLLECTION DEDICATED TO POLAR AND ALPINE MICROORGANISMS

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ABSTRACT

The number of microbial strains isolated from polar and alpine areas is increasing and they are recognized as valuable resources in fundamental studies, such as ecology, physiology, and –omics. Thus, the necessity of culture collection dedicated to the polar and alpine microorganisms has increased. Korea Polar Research Institute (KOPRI) established the Polar and Alpine Microbial Collection (PAMC) to share biodiversity information and bio-resources collected from polar and alpine areas in science and public communities. Approximately 2,000 out of 6,500 strains maintained in PAMC have been identified and belonged primarily to the phyla Actinobacteria, Bacteroidetes, Firmicutes, and Proteobacteria. Many of the microbial strains of PAMC can grow at low temperature and produce proteases, lipases, and/or exopolysaccharides. PAMC provides search tools based on keywords such as taxonomy, geographical origin, habitat and physiological characteristics. Biological materials and information provided by PAMC will be important resources for those who have had no opportunity to visit polar and alpine areas and are expected to contribute to the development in the extreme life sciences (PE14080).

IMPACTS OF GLACIER RETREAT ON NEARSHORE MARINE BENTHIC COMMUNITIES IN A GLACIAL EMBAYMENT, KING GEORGE ISLAND, ANTARCTICA

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ABSTRACT

Impact of glacier retreat on Antarctic nearshore benthic communities was assessed in a representative glacial embayment (Marian Cove) in Maxwell Bay, King George Island. We collected specimens by SCUBA diving from the two contrasting sites; the inner cove (near to the retreating glacier) and the outer cove (far from the glacier). We determined the communities' difference in terms of species richness and taxonomic distinctness (TD), and analyzed the differences in relation to environmental characteristics. The species richness was significantly lower at the inner cove (38±2, n=3) than at the outer cove (65±13.3, n=3), whereas TD values were similar, indicating two sites were taxonomically distinct each other. Water column properties showed significant differences down to 30 m depths between the two sites; colder and less saline at the inner cove, apparently due to higher glacial runoff near to the glacier. Moreover, compared to the outer cove, sea water temperature and salinity varied highly irregularly with depth and with time at the inner cove, indicating the inner cove was subjecting to changes of seawater properties more frequently and rapidly following glacier breakup occurring nearby. The inner cove was also characterized by higher percentages of muddy sediment at the bottom, reflecting higher sedimentation rates. Water column chlorophyll *a* concentrations were significantly higher at the outer cove, which persisted throughout the summer. Organic carbon contents in the surface sediment were also significantly higher at the outer cove, which strongly suggests that more food (benthic diatom etc.) is available for the benthic fauna at the outer cove, likely an explanation for the higher species richness at the outer. We, however, observed at both sites several opportunistic ascidian species including *Molgula pedunculata*, *Cnemidocarpa verrucosa*, *Ascidia challengeri*, indicating that the almost entire area of the cove is likely under the influence of physical perturbation following glacier retreat, although the physical instability is likely decreasing greatly with increasing distance from the glacier. What's more, *M. pedunculata* occurred as dense colonies (~148 inds/m^2) at the outer cove, suggesting that high food availability with a moderate level of disturbance sustain this rapidly growing and reproducing species. The result from this study provides early evidence that physical changes in habitat characteristics following glacier retreat and its consequent processes had impacted the benthic communities, reducing the species richness. The overall findings strongly suggest a potential of

Antarctic nearshore megabenthic epifauna to respond timely to climate change. It is of paramount importance, therefore, to monitor, on a long-term regular basis, the changes in these benthic communities and further to assess in a quantitative way the impacts on their diversity.

ISOLATION OF A LOW TEMPERATURE-REGULATED *CBF*/*DREB*-LIKE GENE FROM *DESCHAMPSIA ANTARCTICA* DESV. AND DEVELOPMENT OF STRESS-TOLERANT RICES

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ABSTRACT

C-repeat/dehydration-responsive element binding factors (CBF/DREBs) are a family of transcription factors that plays a key role in regulating freezing tolerance, binding to the DRE/CRT cis-acting elelments commonly present in stress responsive genes in plant species. As a step towards understanding the stress response of *Deschampsia antarctica*, the only natural grass species colonized in the Maritime Antarctic, we have researched CBF genes in *Deschampsia antarctica* and isolated *DaCBF7* predicted to contain a 816 bp open reading frame by using RT-PCR and RACE. The expression of the *DaCBF7* is highly induced by low temperature but not by high salinity, dehydration or abscisic acid (ABA). The *DaCBF7* transcripts were rapidly accumulated in leaves upon cold stress treatment. To understand the molecular function of the transcription factor, we analyzed the cellular localization of *DaCBF7* using GFP fusion constructs. We generated transgenic-plants over-expressing *DaCBF7* using rice (*Oryza sativa L.*) and found that the overexpression of *DaCBF7* in transgenic rice increased the tolerance to cold stress.

PSYCHROSERPENS MARINUS SP. NOV., ISOLATION FROM ANTARCTIC

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ABSTRACT

A Gram-stain-negative, yellow-pigmented, aerobic, rod-shaped, non-motile bacterium, designated strain PAMC27130^{T}, was isolated from seawater. Optimal growth of strain PAMC27130 ^{T} was observed at 15 ℃, pH 7.0 and the presence of 2% (w/v) NaCl. Phylogenetic analysis based on 16S rRNA gene sequences showed that strain PAMC27130 ^{T} belonged to the genus *Psychrosepens* and was closely related to *psychrosepens* mesophilu (97.2% sequence similarity), *psychrosepens* damuponensis (94.7% sequence similarity) and *psychrosepens* burtonensis (94.2% sequence similarity). The major respiratory isoprenoid quinone menaquinone-6 (MK-6) and major polar lipids were phosphatidylethanolamine.On the basis of genotypic and phenotypic data collected in this study, it is proposed that strain PAMC27130 ^{T} represents a novel species of the genus *psychrosepens*, for which the name *psychrosepens* marinus sp. nov. is proposed. (PE14080)

SPATIAL PATTERNS OF TERRESTRIAL VEGETATION AT MULTIPLE SPATIAL SCALES IN BARTON PENINSULAR OF KING GEORGE ISLAND LOCATED IN THE MARITIME ANTARCTIC

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ABSTRACT

Spatial patterns of terrestrial vegetation at multiple scales were analysed in order to elucidate factors affecting on the species diversity and distribution of mosses and lichens in Barton peninsular of King George Island located in the maritime Antarctic. Main factors affecting on the species diversity of vegetation communities were varied with spatial scales. Species diversity was strongly correlated with plant-plant competition at the small scale(5m X 5m) below plant community patch which has dominant species. While, soil moisture content and interference of bird were strongly correlated with spatial distribution of species diversity at the intermediate scale (40m X 70m) in mountainous area where is partly affected from nest of birds and soil moisture gradient related on micro-topograph. In this intermediate scale, spatial heterogeneity of soil moisture content was mainly associated with slope aspect, micro-topograph and gravel size of adhesion substrate. In a landscape scale of barton peninsula, spatial distribution of species diversity was affected from abiotic factors such as elevation, slope degree, topograph, and water condition. We concluded that primary factors affecting on spatial distribution of species diversity and each species itself are their adaptability to moisture content and spatial heterogeneity of environmental factors such as elevation, topograph, and micro-topograph causing soil moisture grade at the terrestrial vegetation composed of mosses and lichens in Barton peninsula.

Keywords:
Spatial heterogeneity, Species diversity, Barton peninsula, Antarctic, Moss, Lichens, Multiscale, King George Island.

ANALYSIS OF COMPLETE GENOME SEQUENCE OF ADENOVIRUS DETECTED FROM SOUTH POLAR SKUA (*CATHARACTA MACCORMICKI*) IN ANTARCTICA

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ABSTRACT

Adenoviruses (family *Adenoviridae*) have been identified from various hosts: mammals, birds, ruminants, reptilians, marsupials, frogs and fish, but not previously from organisms in the polar region. In this study, we detected the novel adenovirus has a total length of 26,340bp, in various tissue samples of six of thirteen South Polar skuas (*Catharacta maccormicki*), collected in Lake King Sejong, King George Island, Antarctica, from 2007 to 2011. The DNA polymeras, penton base, hexon and fiber genes of the South Polar skua adenovirus A (SPSAdV-A) exhibited 68.3%, 75.4%, 74.9% and 48.0% nucleotide sequence similarity with their counterparts in Turkey adenovirus 3 (TAdV-3). Phylogenetic analysis based on the entire genome revealed that SPSAdV-A belonged to the genus *Siadenovirus*, family *Adenoviridae*. This is the first evidence of a novel adenovirus, SPSAdV, from a large polar seabird (family Stercorariidae) in Antarctica.

GENETIC ANALYSIS OF A NOVEL ADENOVIRUS DETECTED FROM CHINSTRAP PENGUINS (*PYGOSCELIS ANTARCTICA*) IN ANTARCTICA

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ABSTRACT

Adenoviruses (family *Adenoviridae*) infect various sites, and cause diseases in many species. Adenoviruses have been detected from a wide range of host species. In this study, we tested detection of adenovirus from Chinstrap Penguins (*Pygoscelis antarctica*), because no previous reports have identified the detection of adenovirus in Antarctic Penguins. Adenovirus detection was performed by PCR in various organ samples of ten Chinstrap Penguins collected in Antarctica during 2009 and early 2010. The hexon gene of 855 bp among the PCR product was selected for phylogentic analysis. The hexon nucleotide sequence of Chinstrap Penguin adenoviruses (CSPAdVs) showed similarity with South polar skua A (SPSAdV-A) 71.8%, raptor adenovirus 1 (RAdV-1) 71% and Turkey adenovirus 3 (TAdV-3) 71.4%. Based on the genetic analysis, we classified CSPAdVs as novel adenovirus to genus *Siadenovirus*. In conclusion, this study provides the first detection of new adenovirus species from Antarctic penguins.

THE FORMATION OF BIOFILM BY ANTARCTIC MARINE BACTERIA IN A MICROFLUIDIC DEVICE WITH A TEMPERATURE GRADIENT

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ABSTRACT

Polar biofilms have become biological issue since new phenotypes have been discovered in microorganisms in the polar region. It is caused by particular polar environments to affect the functionality of their viability. One of environmental factors is extremely cold temperature which is not easy for non-polar microorganism to survive. To understand their distinctive biological phenomena, it is crucial to study of the development of polar biofilms as a function of temperature. Here, we present a simple and one-pot assay for analysis of the effect of temperature on formation of Antarctic bacterial biofilm using a microfluidic system where temperature gradients are generated continuously. It turned out that the biofilms was formed at specific range of temperature, depending on the type of bacteria. Thus, this microfluidic approach provides precise information regarding the effective temperature for polar biofilm development with a new high-throughput screening format.

DEVELOPMENT OF DROPLET MERGING SYSTEM IN MICROFLUIDIC DEVICE FOR BIOLOGICAL REACTIONS

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ABSTRACT

Microtiter plate is a well-established technology to carry out various biochemical reactions such as medical or pharmaceutical experiments, and enzyme-linked immunosorbent assay (ELISA). However, the microtiter plate method has some limitations including large consumption of reagents and long reaction time, and high cost of robots used in automated system. Recently, droplet based microfluidic system has been intensively highlighted as an alternatively emerging technology. The droplet based microfluidic system allows reducing the consumption of expansive reagents and reaction time, and enhancing efficiency through automated high-throughput screening system.

In this study, we present pillar-based droplet merging systems in microfluidic device for accomplishing chemical and biological reaction. Basically the aqueous droplets including different chemicals are generated by microvalve actuation in microfluidic device. Also, we precisely control droplet size through manipulation of actuation time. Two different droplets are coalescensed at droplet merging chamber composed of micropillar structures in expanded microchannel. When the first droplet enters the merging chamber, micropillar structures induce Laplace pressure for effective standstill of the first droplet that subsequently merges with the secondly entered droplet. The merged droplets are escaped from pillar structures followed by shape recovery of droplet as as a sphere by interfacial tension. Furthermore, we demonstrate application of chemical and biological reactions in droplet merging systems in microfluidic device. Several reactions, such as analysis of adenosine diphosphate (ADP), enzyme reaction, and calcium carbonate formation, have been performed as a proof of concept.

To perform the reactions, two different reagents, substrates and fluorescence quenched reagent, substrate and enzyme, and positive and negative ions are individually used for the each reaction. We measure the reaction activity in microfluidic device by monitoring the change of fluorescence intensities and particle formation.

In conclusion, we have developed a microfluidic device with merging chamber for biochemical reaction by sequential merging of two different droplets. We believe that this microfluidic system is highly expected to facilitate the several chemical and biological reactions with finely controlled reaction condition, rapid reaction, and minimized amount of reagents that is hardly achievable by the conventional microtiter plates.

MORPHOLOGY, DNA BARCODING AND PHYLOGENETIC RELATIONSHIPS OF THE BANGIALES (RHODOPHYTA) FROM KING GEORGE ISLAND, THE ANTARCTIC AND ITS ADJACENT WATERS

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ABSTRACT

Members of the Bangiales (Rhodophyta) are distributed worldwide from tropic to Antarctic and Arctic waters. Three species of the Bangiales *Bangia* sp. (as *B. atropurpurea*), *Porphyra plocamiestris* and *Pyropia endiviifolia* (as *Porphyra endiviifolium*), have been reported in the Antarctic. Morphological and molecular data were investigated for the Bangiales from the Antarctic and its adjacent waters. Each six sequences of SSU rDNA, plastid *rbc*L and mitochondrial *cox*1 gene were newly determined in this study. Molecular data from over 72 taxa of the Bangiales worldwide including previously published sequences, indicated that the genera *Bangia*, *Dione*, *Porphyra*, *Pyropia*, *Wildemania* and other related genera be recognized in the Bangiales as in the previous molecular study. *Bangia fuscopurpurea* from the Antarctic was different from *B. fuscopurpurea* from north Pacific (Korea and Japan) by 12 bp in *cox*1 gene sequence. *Porphyra plocamiestris* growing on other macroalgae in sub-tidal zone grouped into the genus *Wildemania* with the species having one or two cell layers in molecular data. *Pyropia endiviifolia* is olive green in color and it allied to a clade with *P. aeodis* from South Africa, *P. cinnamomea* and *P. viridident*ata from New Zealand. The taxonomic issues and phylogenetic relationships of the Antarctic members of the Bangiales were discussed.

MOSS FLORA OF KING GEORGE ISLAND

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ABSTRACT

The objective of this study is to discuss the Moss Flora of King George Island. King George Island is a member of the South Shetland Island, about 65 km long by up to 40km wide, and is located between lat. 63° 50'-57°5'S and long. 57°30'-59°01'W. This island is the key region to study an impact of global climate change due to relatively diverse vegetation compared to the Continental Antarctic. During the summer season in 2012-2013 and 2013-2014 field surveys have been carried out at various sites of the King George Island. All the collected materials were processed into voucher specimens and are currently deposited at the KOPRI (Korea Polar Research Institute) Herbarium. Through this study, we have collected and identified 26 taxa, which include 17 genera and 10 families. The list was provided and habitat of each collection was examined. The previous studies on the Moss Flora of King Geroge Island was conducted by Ochyra. But Chinese scientists reported unrecorded moss species from Ardley Island lately. Therefore Moss Flora of King George Island is still incomplete and more species can be discovered with further investigation. In addition, we will be try phylogenetic and biogeography study using the cosmopolitan species to the further research.

MORPHOLOGICAL CHARACTERISTICS OF THE *CLADONIA CHLOROPHAEA* GROUP

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ABSTRACT

Lichens are symbiotic organisms consisting of heterotrophic, fungal (mycobiont) and photosynthetic algal or cyanobacterial (photobiont) components. Approximately 20,000 species of lichens are distributed from desert to the polar region. Floristically, they are the dominant macrophytes of terrestrial Antarctica with bryophyta. King George Island is located in the way of entrance of Antarctica, known for diverse bryophytes and lichens. The island is regarded as one of the greatest place to reseach about the evolution of lichen-forming fungi of Antarctica. The list of species of lichens in the island may be estimated as more than 252 species. Above all the species, the genus *Cladonia* accounts for almost 25% of the lichen flora. Morphological structures of the genus *Cladonia* are highly varied. Among them, belonging to the so-called *Cladonia chlorophaea* group is notorious for intra-species morphological variation. This group is characterized by brown fruit bodies and scyphose podetia covered with corticate granules or farinose to granular soredia, and known as cosmopolitan distribution. In order to primarily approach to species entity of *C. chlorophaea*, the diagnostic morphological characteristics and morphological variations are discussed in this review. As the second step, the specimens from polar regions as well as southern America will be analysed morphologically and molecularly to clarify species definition of *C. chlorophaea*.

DISTINCTIVE ENVIRONMENTAL CONTROL ON STABLE CARBON ISOTOPE COMPOSITION OF VEGETATION GROWING IN HIGH-LATITUDES

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ABSTRACT

In high-latitudes, the environmental constraints on the plant lives may vary significantly from the low- to mid-latitude regions. The stable carbon isotope composition of vegetation can provide insight on the relative importance of various environmental factors which affect plant photosynthesis and water-use. Based on the compliation of published and new measurement data from high-latitudes (>60°), the relationships between modern vegetation $\delta^{13}C$ and various environmental factors were examined. Very weak correlation with $\delta^{13}C$ was observed for temperature indices, and no relationship existed between precipitation indicies and vegetation $\delta^{13}C$. Instead, vegetation $\delta^{13}C$ showed significant latitudinal variation over sites, decreasing toward the poles. Such patterns were observed for all vegetation types investigated, C_3 plants, mosses, and lichens. Our results differ from the general consensus of strong precipitation control on plant $\delta^{13}C$, derived from the previous regional to global-scale studies focusing mainly on low- to mid-latitude regions. The distinguished pattern found here is interpreted as a combined result of lessened water limitation and enhanced sunlight influence, led by the characteristic conditions of polar environments. The present study supports that polar vegetation has unique ecological constraints, and interpretation of plant-based $\delta^{13}C$ record acquired from the polar regions should be taken with care.

POSTER SESSION

Arctic and Other Related

EFFECT OF PRECIPITATION ON CO_2 EFFLUX FROM TUNDRA LICHEN, MOSS, AND TUSSOCK, COUNCIL, ALASKA

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ABSTRACT

Ecosystem respired CO_2 efflux-measurement in dominant tundra vegetation on the Seward Peninsula of Alaska was examined for spatiotemporal variability, using a manual chamber system. In order to assess the representativeness of CO_2 efflux and to estimate cumulative the efflux, a 40 m × 40 m (5-m interval; 81 total points) plot was used during the growing season of 2011 and 2012. Average CO_2 effluxes in lichen, moss, and tussock tundra were 3.4 ± 1.9, 4.5 ± 1.7, and 7.2 ± 3.5 $mgCO_2m^{-2}mim^{-1}$ during 2011 and 3.2 ± 1.4, 3.9 ± 1.4, and 5.1 ± 2.0 $mgCO_2m^{-2}mim^{-1}$ during 2012, respectively, suggesting that 1) tussock tundra is a significant CO_2 source, especially considering the wide distribution of tussock tundra in the circumpolar region, and 2) the precipitation event is constrained to emit the CO_2 efflux to the atmosphere. Further, soil temperature, rather than soil moisture, held the key role in regulating CO_2 efflux at the study site: CO_2 efflux from tussock increased linearly as soil temperature increased, while the efflux from lichen and moss followed soil temperature nearly exponentially, reflecting differences in surface area covered by the chamber system. Regarding sample size, the 81 total sampling points over June, August, and September satisfy an experimental average that falls within ±10% of full sample average, with a 95% confidence level. However, the number of sampling points for each variety of vegetation during each month must provide at least ±20%, with an 80% confidence level. In order to overcome the logistical constraints, we were required to identify the site's characteristics with a manual chamber system over a 40 m × 40 m plot and to subsequently employ an automated chamber for spatiotemporal representativeness. The accumulative carbon amount from June 28 to September 30 of 2011 and 2012 was 762 and 539 gCm^{-2}, demonstrating that soil moisture that directly depends on the precipiration event is a significant role in regulating carbon amount during the growing season. Also, soil temperature and soil moisture during the growing season indicate the distinctly different pattern, which soil temperature shows a similar pattern for both years; however, soil moisture represents a signicant difference for 2011 and 2012.

MACROMOLECULAR COMPOSITIONS OF PHYTOPLANKTON AND PROXIMATE COMPOSITIONS OF MESOZOOPLANKTON IN THE NORTHERN CHUKCHI SEA

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ABSTRACT

Macromolecular (proteins, lipids, and carbohydrates) composition of phytoplankton and proximate (water, proteins, lipids, and ash) and elemental (carbon and nitrogen) compositions of mesozooplankton were determined in the northern Chukchi Sea to find a relationship between zooplankton and phytoplankton as a food source. Lipid contents were highest (58.4 ± 8.2%) whereas protein contents were lowest (16.1 ± 7.3%) among the different macromolecular compositions of phytoplankton in this study, which is believed to result from a consequence of nitrogen deficiency in phytoplankton growth during the study period. In contrast, proteins (59.7 ± 10.6% DW) were the major proximate components in the mesozooplankton community dominated by copepods upto 71% of total abundance. The low lipid contents (13.8 ± 12.4% DW) in the mesozooplankton community in this study might be due to dominance of small forms such as *Calanus glacialis* which generally have relatively lower lipid contents than large copepods. Moreover, the spawning period of *Calanus glacialis* from April to June might be an additional reason for the low lipid contents since copepods have normally very low lipid contents after their spawning periods. Due to low lipid contents, low energy contents were observed in the mesozooplankton community in the northern Chukchi Sea.

INTERMITTENT EXPULSION OF WARM METHANE FLUID FROM MUD VOLCANO IN THE CANADIAN BEAUFORT SEA

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ABSTRACT

The Canadian Beaufort Sea is one of the most prominent areas to study geologic features related to gas hydrate in association with permafrost environment because the continental shelf experienced subaerial cold conditions during the Last Glacial Maximum (LGM) and long-term warming occurred since then. Expedition ARA04C using IBRV Araon was carried out in the Canadian Beaufort Sea during September 6-24, 2013 as part of a Korea/Canada/USA international cooperative research program. During the expedition several attempts to measure geothermal gradients using a 5-m-long heat probe were made at a total of eight sites: 1) the inside/outside of a flat-topped mud volcano where fluid expulsion was observed by echosounder, 2) along the eastern slope of the Mackenzie Trough where permafrost below the seafloor degrades basin-ward, and 3) at a background location close to sites of IODP pre-proposal #753 on the continental slope, where no permafrost below the seafloor is expected and also no vertical fluid expulsion features occur. Results from our measurements on the flat top of the mud volcano seem to support the evidence that warm methane-rich fluid has intermittently been emitted through sediments into the ocean. For instance, we find: 1) a much higher geothermal gradient than that from the outside of the mud volcano as well as the background value from the regular seafloor, 2) a much higher seafloor temperature compared with bottom water temperature, and 3) a significantly high methane concentration from the water samples. On the other hand, both substantial variability in the geothermal gradients and seafloor temperatures equilibrated with surrounding water from the eastern slope of the Mackenzie Trough area indicate a possible geothermal perturbation by permafrost. Unfortunately, in-situ thermal conductivity was not measured due to instrument malfunction. Further detailed heat flow analysis together with sediment core analysis may improve our understanding of the nature of methane expulsion emitted from marine sediments in connection with the degradation of permafrost over the arctic shelf.

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LATITUDINAL VARIATION OF PHYTOPALNTKON PRODUCTION IN MELT PONDS, ARCTIC

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ABSTRACT

Using a ^{13}C-^{15}N dual stable isotope tracer technique, the carbon and nitrogen uptake rates of phytoplankton in melt ponds were measured between 74-84 °N at three different cruises during summer 2005 (74-76 °N), 2008 (82-84 °N), and 2011 (77-78 °N), in the Arctic Ocean. Overall, a linear relationship between particulate organic carbon (POC) and chlorophyll a concentration was observed in this study. The highest average concentration of POC was found in 2005 (mean ± S.D. = 126.61 ± 76.24 mg C m^{-3}), whereas the lowest was in 2008 (mean ± S.D. = ± 19.17 mg C m^{-3}). Carbon uptake rates of phytoplankton in melt ponds ranged from 0.03 to 2.12 mg C m^{-3} h^{-1} (mean ± S.D. = 0.47 ± 0.58 mg C m^{-3} h^{-1}), 0.01 to 0.34 mg C m^{-3} h^{-1} (mean ± S.D. = 0.09 ± 0.11 mg C m^{-3} h^{-1}), and 0.01 to 2.12 mg C m^{-3} h^{-1} (mean ± S.D. = 0.35 ± 0.63 mg C m^{-3} h^{-1}) for 2005, 2008, and 2011, respectively. The overall uptake rates of total nitrogen (nitrate + ammonium) ranged from 0.004 to 0.962 mg N m^{-3} h^{-1} in this study and the lowest mean values (mean ±S.D. = 0.015 ± 0.018 mg N m^{-3} h^{-1}) were recored in 2008. Additionally, the average nitrogen uptake in melt ponds were 0.269 mg N m^{-3} h^{-1} in 2005 with relatively large spatial variation (S.D. = ± 0.338 mg N m^{-3} h^{-1}) in the Arctic. In this study, the carbon and nitrogen uptake rates in melt ponds decreased from low to high latitudes. The large difference in carbon and nitrogen uptake rates could be explained by seasonal/spatial variation in phytoplankton biomass.

THE IDEA OF PRACTICAL STRATEGIES REGARDING POLAR OCEANS: BY ANALYZING POLICIES OF MAJOR COUNTRIES AND INTERNATIONAL INSTITUTES

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ABSTRACT

Polar oceans hold great value as a rich repository of natural resources and a significant place for research on and preparation for changes of global environment which have progressed at an alarming rate. The Arctic ocean has a great wealth of resources such as natural gas, petroleum and underground resources, and the outcome of monitoring climate change conducted in the Arctic ocean is very valuable in estimate global climate change.

As for the Antarctic, although it does not allow recognized, dispute, or establish territorial sovereignty claims, each country has fiercely competed themselves in the field of science research . The Arctic Ocean also needs to conduct joint exploitation with surrounding countries.

This paper plans to suggest Korea's future policy direction for Polar oceans by considering major countries' polar oceans policies including those of Russia, the U.S., Australia, UK, Chine and Japan and by analyzing the provisions of international organizations such as UN convention on the Law of the Sea(UNCLOS), International Maritime Organization(IMO), the Antarctic Treaty and provisions on marine environment of Arctic Council.

NUMERICAL EXPERIMENT OF TIDAL EFFECT ON THE ARCTIC OCEAN USING AN ICE-COUPLED OCEAN MODEL

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ABSTRACT

We investigated the interannual variation of sea-ice in the Arctic Sea using an ice-coupled Ocean General Circulation Model (OGCM). The OGCM used in this study is the Regional Ocean Model System (ROMS) version 3.4, which is a three dimensional, s-coordinate, primitive equation ocean model with a free surface. The sea-ice model consists of two main components; ice dynamics [Hunke and Dukowicz, 1997; Hunke, 2001] based on the elastic-viscous-plastic (EVP) ice rheology, ice thermodynamics [Mellor and Kantha, 1989]. The model covers the Arctic Sea north of 55˚N with an orthogonal curvilinear grid system. The horizontal grid size ranges from 27 to 43 km. A total of 70 s-coordinate levels are adopted along the vertical direction with enhanced resolution near the surface.
A set of 12-hourly ECMWF (European center of medium range weather forecasting) reanalysis data with 0.75° resolution during the period from 1979 to 2013 is used to calculate turbulent air/sea and air/ice fluxes. We used SODA (Simple Ocean Data Assimilation) Global 1/2˚ data for temperature and salinity along inflow open boundaries.

**Sponsor : supported by the Korea Polar Research Institute, Grant No. PM13020.

A METAGENETIC APPROACH TO THE SMALL SOIL METAZOAN COMMUNITY OF SVALBARD: LOCAL AND GEOGRAPHICAL PATTERNS OF VARIATION IN COMMUNITY STRUCTURE

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ABSTRACT

One of the greatest challenges in understanding polar ecosystems is to understand how the patterns of diversity and community composition of organisms adjust themselves to local microclimates, and differences in the availability of resources. Over the years, very little attention has been given to small soil metazoans in the polar region and partly due to the practical difficulties of sampling and identifying nematodes in remote locations using traditional morphological criteria under a microscope. However, in this study, we use metagenetic techniques to study metazoan ecology in polar environments, potentially opening up a much more complete picture of the true diversity and composition of the metazoan community.

This study aims to use environmental DNA-based methods to investigate and answer the following questions: 1) Is there a strong latitudinal difference in soil metazoan alpha- and beta- diversity between the high arctic (Svalbard) and the temperate zone (Korea). 2) Is there a difference in nematode alpha- and beta- diversity between the different main tundra types of Svalbard? 3) What soil parameters best predict metazoan diversity and relative abundance within the Svalbard tundra. 4) Are nematode communities in different microsites (amongst plant roots, under rocks, on open bare ground etc.) distinct from one another? 5) How is the soil metazoan community affected by presence of root systems of certain species of tundra plants?

Overall in our results so far, the metazoan alpha diversity of the temperate zone seems higher than the arctic region, but there is no difference of beta diversity between the two regions. On the other hand, the diversity of nematodes between the different tundra types (distinguished by degree of vegetation cover) suggests that alpha diversity was no different between them, yet beta diversity was highest in intermediate vegetation cover tundra. Among soil parameters (pH, P_2 O_2 , NH_4 , TN, TOC), TN was negatively correlated with metazoan alpha diversity ($p=0.045$) and pH was marginally positively correlated ($p=0.0597$). Among microsites, the nematode community of bare ground and rhizosphere differed from other microsites (under rock, under moss, inside polygon) ($p<0.05$). Metazoan communities from rhizosphere samples of 2 plant species (*Carex parallela* , *Silene acaulis)* were not different from each other. However, when the rhizospheric metazoan community was compared with bare patch community, they were distinct from each other ($p=0.016$).

These results together suggest that small soil metazoan in the Svalbard tundra are quite generalized across the landscape, but show significant niche differentiation between microsites such as bare patches vs root zones of plants. Soil parameters such as N and C also significantly correlate with metazoan

community structure. Overall, the Svalbard tundra has a lower metazoan alpha diversity than Korean temperate forest, but perhaps due to its small scale heterogeneity its beta diversity is as high in both ecosystems.

GAS-GEOCHEMICAL FEATURES OF SEDIMENTS IN THE EAST-SIBERIAN AND CHUKCHI SEAS (EASTERN ARCTIC)

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ABSTRACT

Summary
The results of comprehensive study on sediments of East-Siberian Sea along 560 km the NS profile sampled each 10 km from Billings Cape to Mendeleev Ridge and geochemical outcomes from Chukchi Sea are presented (fig.1). For the first time the features of hydrocarbon gases distribution in sediments are described in relations with grain size and chemical compositions. Gas seepage on neo-tectonic faulting is found. Methane anomalies in sediments up to 2.4% are controlling by neo-tectonic faults and typical for gashydrates areas. Isotopic ration of δC^{13}-CH_4 indicates thermogenic gas presumably. The number of chemical elements (Mn, Cu, Ag) are concentrating in the fault zones accompanied methane anomalies due to specific geochemical environment. The chemical composition of bottom sediments in the Chukchi and, partly, East Siberian Seas was studied. In the south and west of the Chukchi Sea, a zone has been detected with the accumulation of sediments rich in organic carbon, an increased background content and anomalies of sulfophile metals (Mo, Zn, Hg, Ag, Au), metals of the iron group (V, Ni, Co), and some PGE (Ru, Pt). This zone is confined to the neotectonic active system of rift troughs extending from Bering Strait and eastern Chukchi Peninsula to the continental slope, where it is bounded by the Cenozoic Charlie rift basin of the Canadian hollow. Obtained data could be applied for hydrocarbon deposits forecasting in study area.

Key words: gasgeochemistry, East-Siberian Sea, Chukchi Sea, methane, hydrocarbon gases, gr anulometry, chemical element composition, organic carbon, tectonics.

The gas geochemical survey in bottom sediments has revealed methane presence in all samples: from 2.0 ppm to 2.4 % (fig. 2). Background concentrations of methane have made 3-4 ppm. In the central part of the profile is allocated slight methane seep (CH_4 2.4 vol. % in the sediment, station 270) with huge concentration, typical for gas hydrate sediments of Okhotsk Sea. Heavy hydrocarbons in the bottom sediments are presented by ethane (the maximum value is 0.43 ppm), ethylene, propylene (max is 0.61 ppm), the propan (max is 0.33 ppm), butane (max is 0.7 ppm) and pentane (max is 17 ppm). For 14 gas samples from the various sites of a profile the isotope structure of carbon of methane, этана and carbonic gas has been defined. The δC^{13}-CH_4 changes from -27.7 to-72.2 ‰ VPDB; ethane - from-17.0 to-31.8 ‰ VPDB; carbon dioxide - from-17.7 to-23.7 ‰ VPDB. The obtained data of carbon isotope structure fall within the limits of values, typical for gases of coal and gas bearing and oil and gas bearing

sedimentary formations of the northeast of Russia.
According to our data, the carbon isotope composition of methane and ethane from the East Siberian Sea concerns gases with the mixed genesis (thermogene and bacterial) with prevalence of a thermogene share. Methane -45.8-56.1 ‰ VPDB (stations 40-60) is typical for coal formations. Methane with "heavy" carbon composition is found out at station 90: -27.9 ‰ VPDB. Such methane is close to methane of the Sakhalin mud volcanoes. Methane with "easy" carbon composition (-72.2 ‰ VPDB) is fixed at station 280, in the area where its maximum concentration in sediments are defined. Generally, at seepage of natural gas from the congestion of hydrocarbons, thermogene a component should prevail. However in places with active "cold" methane manifestations (such as hydrocarbons), gas with rather easy composition of carbon, for example, a northeast slope of Sakhalin Island (Okhotsk Sea) where δC^{13}-CH_4 changes from-55 to -77.5 ‰ VPDB is often found out. This feature is explained by active microbiological processes in the top layers of bottom sediments where occurs multievent fractionation of carbon, including arriving from thermogene sources and injecting microbiological communities. It is possible to assume that the methane with «easy» carbon in the areas of permeability, is not typically microbiological, and on the contrary, specifies in presence of inflow of hydrocarbon fluids from deep horizons of sedimentary thickness. Probably, it explains the presence of «easy» carbon of methane isotope structure at station 280 (the given site is supervised by a tectonic fault). It proves to be true also in values of carbon isotope structure of carbon dioxide (-23.5 ‰ VPDB): values are comparable to average size of carbon isotope structure of carbon dioxide from samples where in carbon isotope structure of methane prevails thermogene a component.

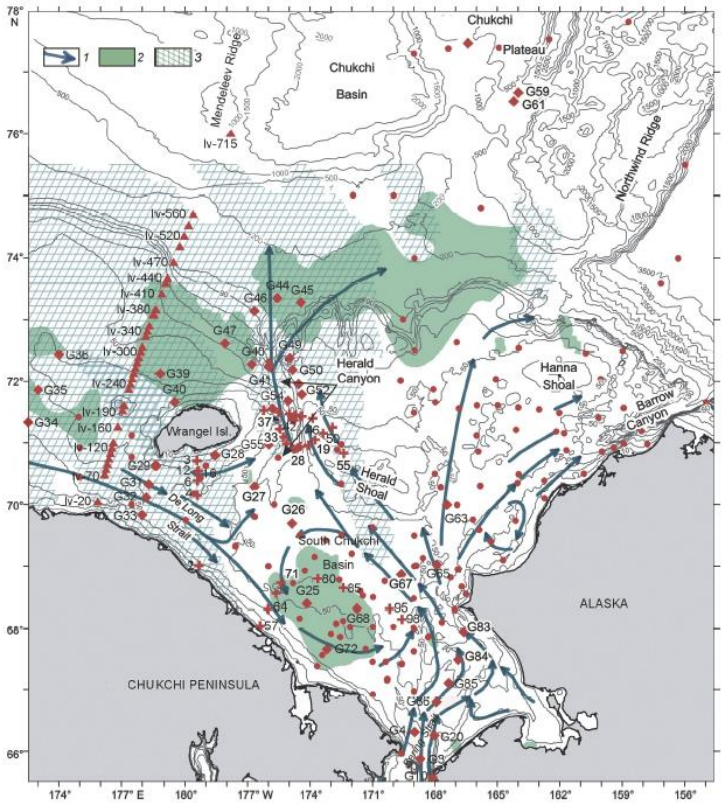

Fig. 1. Sites of bottom-sediment sampling (red symbols): triangles, stations of the RV Akademik M.A. Lavrentyev (2008); diamonds, stations of the seagoing tug Shuya (2006); crosses, stations of the RV Professor Khromov (2009); and circles, stations from the previous studies (Astakhov et al., 2010b, 2013; Feder et al., 1994; Viscosi-Shirley et al., 2003). 1, direction of the predominant surface currents (Grebmeier et al., 2006); 2, 3, distribution of oxygen-deficient bottom waters (<6 mL/L) (Frolov, 2008): 2, summer; 3, winter.

An average value of carbon isotope structure of carbon dioxide coincides on genesis sign with carboniferous thicknesses with high level of metamorphism (for example, coal deposits of Sakhalin). Molecular weight of gaseous hydrocarbon fraction (MHM - the weight average value of individual members of C1-C5) and weight concentration of hydrocarbon gases, valuated in relation MHM, were investigated as a uniform quantity indicator of genesis features of heavy hydrocarbons. An average value of MHM 25.31 defined on the profile, is characteristic for gases of oil-and-gas and oil deposits, thus weight concentration of C1-C5 (600-6-8-27-360) confirm that the gas geochemical field is polygenetic formation. Gas components of such field are formed at imposing of deep gases of primary generation coal-and-gas and oil-and-gas numbers and the gases formed at repeated-migratory processes. Thus, by the results of gas geochemical researches in the East Siberian Sea there are preconditions of detection of hydrocarbon deposits. Thus, the contribution of deep substance is probable, and its migratory inflow to the top part of the profile creates areas of abnormal gas geochemical fields. The number of chemical elements (Mn, Cu, Ag) are concentrating in the fault zones accompanied methane anomalies due to specific geochemical environment.

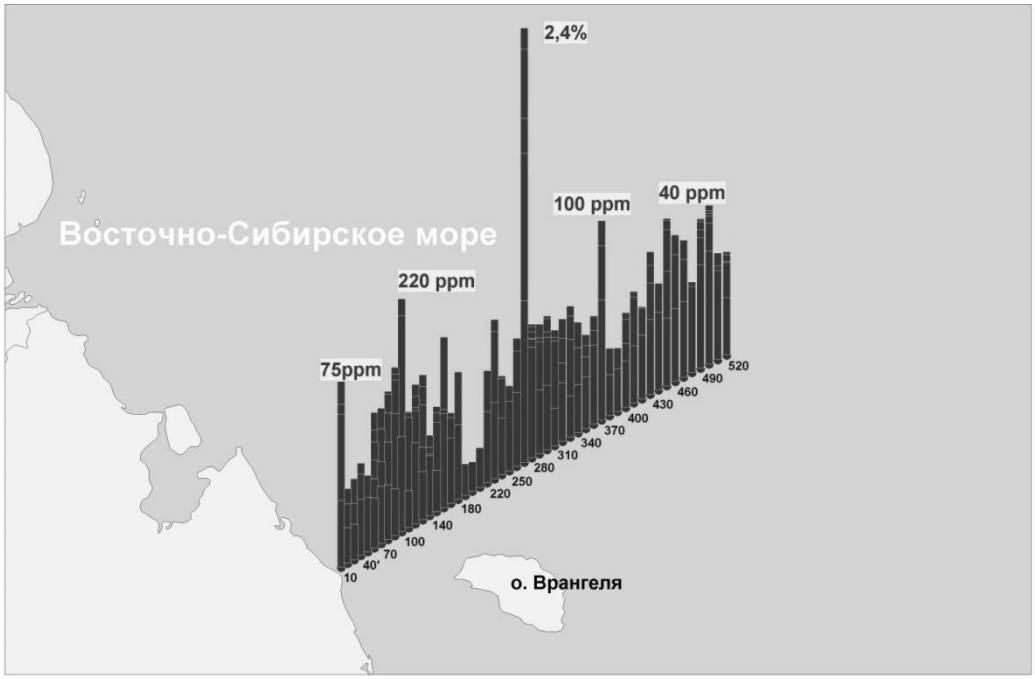

Fig. 2. Methane anomalies in the sediments of the East-Siberian Sea. Methane charts in the sediments (ppm).

The Chukchi Sea bottom sediments have increased contents of Ag, Mo, Cd, Zn, Cu, P, V, Au, and Ba with respect to average ones in the crust and sedimentary rocks, as is typical of oxygen-deficient sea basins. Sediments enriched in organic carbon with respect to the background accumulate in the narrow zone of the neotectonic structure of the Chukchi graben and some other structures of the graben–rift system. They have a considerably lower Si content, increased Fe, Al, and Mg contents, and even higher contents of Mo, Zn, V, and Au. Analysis of data using multivariate statistics revealed the grain size of sediments and organic-carbon content as the main factors of the background accumulation of the above metals. A correlation of organic carbon with both biogenic elements (in this case, Ca, Mg, Sr, Pb) and metals (Hg, Mo, Zn, V, Cr) was established with the effect of grain size eliminated by normalization to Al. Besides that, the neotectonically active structures accumulating organic-enriched bottom sediments contain points with an anomalous content of sulfophile metals, including precious ones. The geologic conditions surrounding the accumulation of organic-carbon-enriched sediments with an anomalous content of metals, as well as their lithologic and geochemical characteristics, are evidence for different causes of anomaly formation. Anomalous contents of Mo, V, Ag, and Ru are likely to form in local

areas with anoxic bottom or entrapped waters developing near cool gas or water-gas vents. On the other hand, anomalous contents of Fe, Mn, Zn, Hg, Ni, and Au are likely to form near water (including thermal) springs supplying metals or creating favorable physicochemical conditions for various ways of metal deposition from bottom or entrapped waters. It is evident that biochemical processes play an important role and part of the anomalies might have been produced during early diagenesis. In turn, accelerated diagenesis might have been initiated by the same fluid sources. Thus, bottom sediments enriched in organic matter and metals develop in the Chukchi Sea mainly owing to peculiar geodynamic settings: recent fluid activity and long-lasting crustal extension with the formation of a system of troughs (grabens) reflected in the bottom topography. Importantly, the dissolution of biogenic carbonates and the absence of intense supply of terrigenous matter are the causes of the low sedimentation rate. Favorable oceanologic conditions, including the stratification of the water column and the supply of warm Pacific waters through the Bering Strait, are a secondary and, probably, nonessential factor.
Obtained data could be applied for deep fluid tracers' and hydrocarbon deposits forecasting in the polar areas.

**The study was supported by Russian Fund of Basic Research: Grants 14-05-00294 and 13-05-93000 and grants of Far Eastern Branch of Russian Academy of Sciences 12-III-A-07-139 and 14-III-Д-07-039.

WARM EDDY EFFECTS ON THE DISTRIBUTION OF ARCTIC MESOZOOPLANKTON IN THE WESTERN ARCTIC OCEAN

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ABSTRACT

Mesozooplankton with the predominant calanoid copepods play a key role in the pelagic food webs of the Arctic seas, and largely influence the energy flow and functioning of the productive marine ecosystems. Although pelagic copepods are of major importance in Arctic food webs, there are still some uncertainties about their pathways and quantitative roles on the maritime Arctic ecosystem. We document the spatial variation of Arctic mesozooplankton at the Northwind ridge in the western Arctic in relation to two types of warm-core circulations: a cyclone and anticyclone eddy. An acoustic survey was made with multiple frequencies (38 and 120 kHz) to describe the distribution of the mesozooplankton, which was dominated by copepods, in relation to biological and physical factors of the pelagic system in July of 2010. Environmental parameters monitored were temperature and salinity, dissolved oxygen, inorganic nutrients and chlorophyll *a*. Arctic mesozooplankton was collected from the upper 100m water layer in the Pacific summer water, and density was highest within the cyclone eddy, providing an important habitat for mesozooplankton. The high density might be attributed to the nutrient supply and high phytoplankton biomass provided by the cyclone eddy. This relationship could provide useful information for the prediction of Arctic mesozooplankton distribution patterns and their ecology in the future.

DISTRIBUTION OF MYCOSPORINE-LIKE AMINO ACIDS ALONG SIZE-FRACTIONATED PHYTOPLANKTON IN THE BUEAFORT SEA, ARCTIC

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ABSTRACT

The concentration of UV-absorbing compounds (Mycosporine-like amino acids, MAAs), was investigated by comparing the size-fractionated phytoplankton in the Bueafort Sea during Curize RV-ARAON. Chlorophyll a concentration indicated that the dominated phytoplankton was larger than 20 μm phytoplankton in this study area. The concentration of total MAAs displayed that larger phytoplankton (>20 μm) occupied the content of total MAAs concentration. A station which located Mackenzie trough had the highest concentration and the production rate of MAA then other stations. The production rate of individual MAA had the highest value of 0.21 (± 0.02) ngC L-1d-1 and 0.14 (± 0.001) ngC L-1d-1 for shinorine and palythine relavtively. The concentration of the MAA also showed higher values in the quartz incubation bottles than in the PC bottles by comparing the light quality. Though the production rate of shinorine had shown high value in the quartz bottle, the production rate of palythine was similar to that of the quartz and PC incubation bottles. It is possible to understand the changes for newly photosynthesized MAAs in the natural phytoplankton community. The strategy of the phytoplankton for adapting to the different environments and surviving could be verified.

**This research was a part of the project titled 'Korea-Polar Ocean in Rapid Transition (KOPRI, PM13020)', funded by the Ministry of Oceans and Fisheries, Korea.

GREENHOUSE GAS ANOMALIES OBSERVED FROM TSAMBAGARAV (MONGOLIAN ALTAI) ICE CORE

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ABSTRACT

Trace-gas analysis from alpine glaciers can help us to refine the latitudinal distribution of atmospheric methane (CH_4), but once alterated the records are no more represent true atmospheric value. In case of low-latitude alpine glaciers, CH_4 anomalies of 2 to 8 times higher than atmospheric value were reported in Sajama glacier (Campen et al., 2003), East Rongbuk, Dasuopu glacier (Hou et al., 2013) and Colle Gnifetti glacier (Stauffer et al., 2003). However, the main cause of gas anomalies is still not well understood. We present high resolution records of methane and total air content to discuss the alteration of greenhouse gas records in Tsambagarav (Mongolian Altai) ice cores. The measurements were done every 8 cm intervals along the 5 entire core sections (R-2 cut; run 03, 04, 40, 44 and 45). The observed methane concentration spikes are much higher than true atmospheric mixing ratio and even higher than that expected concentrations of gases trapped in refrozen meltwater. In addition, the methane anomalies are greater than previous results from other low-latitude alpine glaciers. The large excesses may imply in-situ methane production by microbial metabolism (Price, 2000). Additional studies on other trace-gases (e.g. carbon dioxide, nitrous oxide) and microbial activity will give further implication on the cause of the trace gas anomalies.

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ANALYSIS OF ENVIRONMENTAL FACTORS DETERMINING DISTRIBUTION OF ARCTIC VEGETATION IN SVALBARD

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ABSTRACT

Distributions of plant species are determined by environmental gradients. Although arctic environment is harsh for the vascular plants due to cold temperature, short growing season, and poor nutrients, diverse plants species are growing in Spitsbergen Island. We measured plant abundance using grid sampling methods and analyzed soil physical and chemical properties. To analyze the critical environmental factors for distribution of arctic plants, we applied diverse data mining methods such as spatial regression, classification trees, Lasso regression, and support vector machine. Plants distributions mainly divided by elevation, pH, and soil water contents. For example, *Salix polaris* frequently found in high region and high soil moisture area, but *Casiope tetragona* and *Dryas octopetala* distributed in low soil moisture and poor nutrient area. Environmental preference of these plants may give important insight about ecosystem changes in response to global warming.

CO_2 AND CH_4 DEPTH PROFILES FROM ALASKAN SOIL CORES: HEADSPACE GAS ANALYSIS FOR TRAPPED GREENHOUSE GASES IN SOIL

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ABSTRACT

Soil respiration is an important part of terrestrial carbon cycle in earth environmental system (Luo et al., 2006). Among the earth's terrestrial system, Alaskan permafrost region has unique environmental conditions within vulnerable soil layers which have potential to release more greenhouse gas related to now and future climate change (Schuur et al., 2008). In this study we focus on the greenhouse gas amount variation through the active layer compared to upper permafrost during winter season. Frozen soils might sequester greenhouse gas, especially as CH_4 under anoxic condition, in their air space because of lowered air-filled porosity (Zhao et al., 2013) during winter, and thawing make degassing during summer. We also focus on spacial distribution of the amount of greenhouse gas in soils. In the spring of 2013 when the active-layer soils in Alaska were just before starting to melt, 90 cm-long permafrost soil cores were drilled at five sites in central and northern Alaska. Along the trans-Alaskan pipeline they have latitudinal variation on environmental conditions, which include boreal forest, wildfire affected forest, and coastal tundra (Kim et al., 2013). Each core was divided into 3 parts longitudinally and one of them was cut into several small pieces still under frozen conditions by a diamond blade. The small soil pieces of each roughly 10 cm^3 were bottled at labeled vials with 10 mL saturated NaCl solution in order to isolate the trapped gas from frozen soil to headspace (Kim et al., 2012 and RESTEK et al., 2000). CH_4, CO_2 and O_2 concentrations in headspace gas were measured for every 5 cm depth intervals from surface to bottom of the cores with Agilent 7890A Gas Chromatograph. The amounts of gas per unit mass of the soils (mg kg^{-1}or mmol kg-^{1}) were within the range of previous results from Alaskan permafrost soils (Michaelson et al., 2011; Rasmussen et al., 1993). One of the depth profiles of CH_4 shows a rapid increase at a certain depth, but the others do not. Further study should include physical and chemical analyses to better interpret the gas depth profiles.

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STRUCTURE-BASED CHARACTERIZATION AND ANTIFREEZE PROPERTIES OF A HYPERACTIVE ICE-BINDING PROTEIN FROM THE ANTARCTIC BACTERIUM *FLAVOBACTERIUM FRIGORIS* PS1

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ABSTRACT

Ice-binding proteins (IBPs) inhibit ice growth through direct interaction with ice crystals to permit the survival of polar organisms in extremely cold environments. FfIBP is an icebinding protein encoded by the Antarctic bacterium Flavobacterium frigoris PS1. The X-ray crystal structure of FfIBP was determined to 2.1 Å resolution to gain insight into its icebinding mechanism. The refined structure of FfIBP shows an intramolecular disulfide bond, and analytical ultracentrifugation and analytical size-exclusion chromatography show that it behaves as a monomer in solution. Sequence alignments and structural comparisons of IBPs allowed two groups of IBPs to be defined, depending on sequence differences between the α2 and α4 loop regions and the presence of the disulfide bond. Although FfIBP closely resembles Leucosporidium IBP (LeIBP) in its amino-acid sequence, the thermal hysteresis (TH) activity of FfIBP appears to be tenfold higher than that of LeIBP. A comparison of the FfIBP and LeIBP structures reveals that FfIBP has different ice-binding residues as well as a greater surface area in the ice-binding site. Notably, the icebinding site of FfIBP is composed of a T-A/G-X-T/N motif, which is similar to the ice-binding residues of hyperactive antifreeze proteins. Thus, it is proposed that the difference in TH activity between FfIBP and LeIBP may arise from the amino-acid composition of the ice-binding site, which correlates with differences in affinity and surface complementarity to the ice crystal. In conclusion, this study provides a molecular basis for understanding the antifreeze mechanism of FfIBP and provides new insights into the reasons for the higher TH activity of FfIBP compared with LeIBP.

CHARACTERIZATION OF TOLL-LIKE RECEPTOR FAMILY GENES OF THE *NOTOTHENIA CORIICEPS* AND MOLECULAR RESPONSES TO PATHOGEN AGONIST

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ABSTRACT

Notothenia coriiceps, a typical Antarctic notothenioid teleost, has evolved to adapt to the extreme Antarctic marine environment. We previously reported an extensive analysis of the Antarctic notothenioid transcriptome. In this study, we focused on a key component of the innate immune system, the Toll-like receptors (TLRs). We cloned the full-length sequence of 12 TLRs of N. coriiceps. The ncTLR genes encode a typical TLR structure, with multiple extracellular leucine-rich regions and an intracellular Toll/IL-1 receptor (TIR) domain. Using phylogenetic analysis, we established that all of the cloned ncTLR genes could be classified into the same orthologous clade with other teleost TLRs. ncTLRs were widely expressed in various organs, with the highest expression levels observed in immune-related tissues, such as skin, spleen, and kidney. A subset of the ncTLR genes were expressed at higher levels in fish exposed to pathogen-mimicking agonists [heat-killed E. coli and poly(I:C)]. However, the mechanism involved in the up-regulation of TLR expression following pathogen exposure in fish is currently unknown. Further research is required to elucidate these mechanisms and to thereby increase our understanding of vertebrate immune system evolution.

VERTICAL DISTRIBUTIONS ON BIOCHEMICAL COMPOSITION OF PARTICULATE ORGANIC MATTER IN THE LAPTEV SEA

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ABSTRACT

Biochemical compositions of particulate organic matter (POM) as an indicator of food quality for higher trophic levels was investigated in the Laptev Sea during the Nansen and Amundsen Basins Observational System (NABOS) research cruise, 2013. Samples for biochemical compositions were obtained from surface water to 200 m water depth at three different stations. Samples were filtered on Whatman GF/F filters (47mm) and the filters were immediately frozen and preserved for colorimetric measurements. Extractions of different macromolecular classes [carbohydrates (CHO), proteins (PRT), lipids (LIP)] were performed and the concentrations were determined by the optical density measured with a spectrophotometer. The PRT cencentrations had a decreasing pattern with increasing water depth in all stations whereas the CHO and LIP concentrations had no specific patterns. The overall average compositions of CHO, PRT, and LIP were 31.9 ± 19.2 %, 6.8 ± 6.2 % and 61.3 ± 17.6 %, respectively. The LIP compositions were highest among all different macromolecular classes ($p < 0.05$, ANOVA). The overall average food material (FM; CHO + PRT + LIP) concentrations were 487.9 ± 213.9 μgL^{-1}. In terms of kcal per cubic meter, the caloric content values of the FM ranged from 0.6 kcal m^{-3} to 7.3 kcal m^{-3} (average ± S.D. = 3.8 ± 1.8 kcal m^{-3}). The relatively higher LIP compositions contributed to high calolific contents, which indicating that LIP might play an important role of maintaining marine ecosystem in the Laptev Sea.

SOCIAL EVENTS

All participants are kindly invited to the social events hosted by KOPRI.

Icebreaker
May 26, 18:00 - 20:00
Orakai Songdo Park Hotel

Banquet
May 28, 18:00 - 20:00
KOPRI Hall

FOR POLAR EARLY CAREER SCIENTISTS

KOPRI has specially prepared two events to promote early career scientists participation in symposium.

For KOREAN Early Career Scientists Gathering

- Date & Time: May 28, 11:30-13:00
- Meeting Place: International meeting room (3rd Floor, KOPRI Main Building)

Young Scientist Awards

- Young Scientist Awards will be presented to the outstanding poster presentations. The award ceremony will take place as a part of the banquet on May 28.

TRANSPORTATION INFORMATION

Between Incheon International Airport and Orakai Songdo Park Hotel

If you will stay at the Orakai Songdo Park Hotel, you can reach the hotel by taking the KAL Limousine Bus No. 6707B. Further information is available at the following website: http://symposium.kopri.re.kr/docs/Trans_info_Airport-SongParkHotel.pdf

Between Orakai Songdo Park Hotel and KOPRI

A shuttle bus between the Orakai Songdo Park Hotel and KOPRI will be provided during May 27-28. The shuttle bus will also stop at the BIT Zone Station (Incheon Subway Line 1). You can find the time table below;

From the Orakai Songdo Park Hotel to KOPRI

Orakai Songdo Park Hotel	BIT Zone Station (Exit #2)	KOPRI
08:30	08:40	08:50
09:10	09:20	09:30

From KOPRI to the Orakai Songdo Park Hotel

KOPRI	BIT Zone Station (Exit #3)	Orakai Songdo Park Hotel
08:30	08:40	08:50
09:10	09:20	09:30
18:20	18:30	18:40
20:10*	20:20	20:30

* A shuttle bus will be provided at 20:10 only on May 28