The 21st International Symposium on Polar Sciences

Polar Region as a Key Observatory for the Changing Globe and Beyond

May 19 - 20, 2015
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 19 (Tuesday)	
09:00 - 09:20	***Registration & Coffee Break***
Opening Ceremony	*Auditorium*
09:20 - 09:30	***Welcome Address***
09:30 - 09:40	***Group Photo***
Plenary Lecture	*Auditorium*
09:40 - 10:20	**Mahlon C. KENNICUTT II** ***A Roadmap for Antarctic and Southern Ocean Science for the Next Two Decades and Beyond***
Sessions	**Lower and Upper Atmospheric Research in the Polar Region** *Auditorium*
10:20 - 10:40	**Esa TURUNEN** ***Highlights of Recent and Future Polar Upper Atmospheric Science in Finland***
10:40 - 11:00	**Hanli LIU** ***Gravity Waves at High Latitudes from High Resolution Waccm Simulations***
11:00 - 11:20	**Kamil LÁSKA** ***Monitoring and Evaluation of Solar Irradiance at Mendel Station, Northern Antarctic Peninsula***
11:20 - 11:40	**Seong-Joong KIM** ***Investigation of Climate Change Mechanism by Observation and Simulation of Polar Climate for the Past and Present***
11:40 - 12:00	**Jun INOUE** ***Arctic Research Collaboration for Radiosonde Observing System Experiment (ARCROSE)***
12:00 - 13:30	***Lunch & Poster Session***
Sessions	**Reconstruction of Past Climate Records and Environment Records** *Auditorium*
13:30 - 13:50	**Edward BROOK** ***New Directions for Ice Core Research in Antarctica***
13:50 - 14:10	**Motoyama HIDEAKI** ***Characteristics of Environmental Signals in Solid Precipitation, Surface Snow and Deep Ice Core at Dome Fuji, Antarctica***

14:10 - 14:30	**Sung Min HONG** ***Elemental and Pb isotopic evidence for different interglacial climates before and after the Mid-Brunhes Event (~430 kyr BP) in the EPICA Dome C ice core***
14:30 - 14:50	**Richard LEVY** ***Threshold Response of the Antarctic Ice Sheet to Atmospheric CO_2 Variability During the Early to Middle Miocene***
14:50 - 15:10	**Jae Il LEE** ***Change in Deep Water Circulation in Southern Drake Passage During the Mid-Pleistocene Transition***
15:10 - 15:30	***Coffee Break & Poster Session***
Invited Lecture	*Auditorium*
15:30 - 16:00	**Kazuyuki SHIRAISHI** ***Japan's Polar Research: A Future Direction***
Sessions	**Planetary Geology and Geological Evolution of the Victoria Land: Reviews and New Views** *Auditorium*
16:00 - 16:20	**John BRADSHAW** ***The Tectonic Framework of Northern Victoria Land in the Paleozoic: Present Status and Outstanding Problems***
16:20 - 16:40	**John ISBELL** ***Permian and Triassic Sedimentation in the Central Transantarctic Mountains, Southern Victoria Land and Northern Victoria Land: A South Polar View of Gondwana During the Paleozoic-Mesozoic Transition***
16:40 - 17:00	**Philip KYLE** ***Cenozoic Alkaline Magmatism and Volcanism in North Victoria Land, Antarctica: A Review***
17:00 - 17:20	**Jusun WOO** ***Korea Antarctic Geological Expedition: A Summary of the First Two Years***
17:20 - 17:40	**Yoonsub KIM** ***Metamorphism and Provenance of the Metasediments in the Wilson Terrane, Northern Victoria Land, Antarctica***
17:40 - 18:00	**Changkun PARK** ***EET 14017 : Newly Recovered LL3.0 Chondrite Meteorites from Victoria Land, Antarctica***

May 20 (Wednesday)	
Plenary Lecture	*Auditorium*
09:00 - 09:40	**Arnold GORDON** ***Bottom Water Export from the Western Ross Sea***
Sessions	**Remote Sensing of the Changing Globe I (Marine)** *Auditorium*
09:40 - 10:00	**Mark C. SERREZE** ***The National Snow and Ice Data Center***
10:00 - 10:20	**Greg MITCHELL** ***Interdisciplinary Coordinated Experiment of the Southern Ocean Carbon Cycle (ICESOCC) – A Field Campaign Scoping Project***
10:20 - 10:40	**Mati KAHRU** ***Evaluation of Errors in Satellite Estimates of Primary Production and Export Production in the Southern Ocean***
10:40 - 11:00	**Hyun-Cheol KIM** ***Satellite Remote Sensing on West Antarctic Ocean Research (STAR)***
11:00 - 11:20	**Eurico D'SA** ***Unraveling Optical Variability of Dissolved and Particulate Matter in the New Zealand Sector of the Southern Ocean During an Austral Summer Using Field and Satellite Observations***
11:20 - 11:40	**Craig STEVENS** ***Flow Around Glacier Tongues***
11:40 - 13:20	***Lunch & Poster Session*** *(Korean Early Career Scientists Gathering)*
Sessions	**Remote Sensing of the Changing Globe II (Terrestrial)** *Auditorium*
13:20 - 13:40	**Claude DUGUAY** ***Assessing the Trajectory of Shallow Arctic Water Bodies from Satellite Observations***
13:40 - 14:00	**Kevin KANG** ***Improvement of Modis Snow Products for Arctic Lake Ice***
14:00 - 14:20	**Hong-Gyoo SOHN** ***Comparison of Dem Generation Methods at the Terra Nova Bay, Antarctica Area***
14:20 - 14:40	**Falk AMELUNG** ***Sensing the Bed-Rock Movement Due to Ice Unloading from Space***

14:40 - 15:00	**Pablo CLEMENTE-COLON** ***The U.S. National Ice Center (NIC) use of Remote Sensing, Model, and In-Situ Data for Operational Monitoring of Global Sea Ice***
15:00 - 15:30	***Coffee Break & Poster Session***
Sessions	**Marine Geophysical Studies in the Polar Region** *Auditorium*
15:30 - 15:50	**Karsten GOHL** ***The West Antarctic Rift System in the Amundsen Sea and Bellingshausen Sea Sectors***
15:50 - 16:10	**Laura DE SANTIS** ***The Hillary Canyon: a Downslope Route for Ross Sea Bottom Water***
16:10 - 16:30	**Jong Kuk HONG** ***Study on Tectonic Activities and Volcanism Near Adare Trough and Australian-Antarctic Ridge***
16:30 - 16:50	**Sridhar ANANDAKRISHNAN** ***Seismicity of David Glacier, Antarctica***
16:50 - 17:10	**Young Keun JIN** ***Overview of 2013-2014 Korea-Canada-USA Beaufort Sea Geoscience Research Program***
17:10 - 17:30	**Kyunghoon SHIN** ***Geochemical Evidences on the Methane Cycling in Relation to Dissociation of Gas Hydrate in the Sediment of the Slope Region, the Beaufort Sea***
18:00 - 20:00	***Banquet***

Symposium Poster Session

May 19-20 (Tuesday-Wednesday)		
Lower and Upper Atmospheric Research in the Polar Region (PS-A00)		
PS-A01	Ji-Young HAM	*Isotopic Variations of Snow by Albedo*
PS-A02	Jinpei YAN	*Interannual and Seasonal Variations of Atmospheric MSA and NSS-SO42- at Zhangshan Station, Antarctica*
PS-A03	Kamil LÁSKA	*Investigation of Structure and Function of Terrestrial Ecosystems at James Ross Island, Antarctica*
PS-A04	Eunji BYUN	*Trapped Greenhouse Gas in Winter Active Layer: Case Study for Alaskan Shallow Soil Cores*
PS-A05	Byeong-Gwon SONG	*Gravity Waves Variability During 2009 Major Stratospheric Sudden Warming Revealed in High-Resolution ECMWF Analysis and GROGRAT*
Reconstruction of Past Climate Records and Environment Records (PS-C00)		
PS-C01	Yeongcheol HAN	*Shallow Ice-Core Drilling on Styx Glacier, Northern Victoria Land, Antarctica in the 2014-2015 Summer Season*
PS-C02	Hun-Gyu LEE	*Firn Air Sampling in Styx Glacier, Antarctica*
PS-C03	Ji-Woong YANG	*Preliminary Results of Methane Concentration and Total Air Content Measurements For GV7 Ice Core, Antarctica*
PS-C04	Ester COLIZZA	*Climatic and Environmental Changes During the Last Glacial-Interglacial Transition in the Ross Sea, Antarctica*
PS-C05	Jong-Sik RYU	*CO_2 Evasion from the Greenland Ice Sheet: A New Carbon-Climate Feedback*
Marine Geophysical Studies in the Polar Region (PS-G00)		
PS-G01	Seung-Sep KIM	*Geophysics of the Australian-Antarctic Ridge*

PS-G02	Sang-Mook LEE	*Analysis of Shipboard Three-Component Magnetometer Onboard IBRV Araon to Reduce the Effect of the Ship During 2015 Antarctic Expedition*
PS-G03	Sookwan KIM	*Antarctic Ice Sheet Evolution during the Mid-Late Cenozoic Time from the Sedimentary Record of the Outer Western Ross Sea Continental Margin, Antarctica*
PS-G04	Choon-Ki LEE	*Surface Elevation Changes on the Subglacial Lakes Upstream of the David Glacier, Antarctica Using Cryosat-2 and ICEsat Satellite Altimetry: A Preliminary Result*
PS-G05	Christine DOW	*Analysis of Sub-Antarctic Lake Stability Using a Coupled Basal Hydrology Model*
PS-G06	Ryan WALKER	*Insights from Viscoelastic Modeling of Ice Streams and Ice Shelves*
PS-G07	Masaki KANAO	*Characteristic Atmosphere and Ocean Interactions in the Coastal and Marine Environment Inferred from Infrasound Arrays at Lãœtzow-Holm Bay, East Antarctica*
PS-G08	Christina HULBE	*Flow Variability of Bindshadler and Macayeal Ice Streams, West Antarctica*
PS-G09	Isak Bowden FLOYD	*Marine Remote Sensing in Polar Regions Using Autonomous Underwater Vehciles*
PS-G10	Cameron EDWARDS	*Flow Interaction of the Drygalski Ice Tongue*
PS-G11	Young-Gyun KIM	*Expulsion of Methane-Rich Warm Fluid from Mud Volcano in the Canadian Beaufort Sea, Arctic Ocean*
PS-G12	Seung-Goo KANG	*Multi-Channel Seismic Survey in the Outer Continental Shelf of the Beaufort Sea*
PS-G13	Sung-Min KIM	*Prediction of Potential Avalanche Release Area for the Antarctic Peninsula*
PS-G14	Rae-Gyung HA	*Microstructures of Magnetic Crystals*
PS-G15	Doohee JEONG	*Core Freezing Recorded by Precambrian Geomagnetic Field*
PS-G16	Hanul KIM	*On the Use of Magnetic Properties for Understanding the Spreading of Oceanic Ridges at High Latitudes*

PS-G17	Hoabin HONG	*Tracing the Geomagnetic South Poles in Antarctica*
Planetary Geology and Geological Evolution of the Victoria Land: Reviews and New Views (PS-P00)		
PS-P01	Margaret BRADSHAW	*Sequence Stratigraphy: A New Approach to the Devonian Taylor Group (Beacon Supergroup) in Southern Victoria Land, Antarctica*
PS-P02	Mi Jung LEE	*Geochemical Constraints on Mantle Sources for Volcanic Rocks from Mt. Melbourne and the Western Ross Sea, Antarctica*
PS-P03	Yun Seok YANG	*Halogen (Cl, Br, I) Geochemistry in Mid-Ocean Ridge Basalts from the Australian-Antarctic Ridge (AAR)*
PS-P04	Young Hwan KIM	*Sedimentary Processes of the Channelized Debris Flow Deposits in the Spurs Formation, the Mariner Group (Cambrian), Northern Victoria Land, Antarctica*
PS-P05	Hwayoung KIM	*Fine-Grained Melilite-Rich Refractory Inclusions in TIL 07003 and 07007 CV3 Chondrites*
PS-P06	Hyeonggyu KIM	*Petrographic Studies of Graphite-Troilite-Silicate Inclusions in Gapyeong Iab Iron Meteorite*
PS-P07	Yeongmin KIM	*Preliminary Study of Mineral Resources in Northern Victoria Land, Antarctica*
PS-P08	Tae-Yoon S. PARK	*Trilobite Biostratigraphy of the Cambrian Spurs Formation at Eureka Spurs, Northern Victoria Land, Antarctica Reveals Structural Deformation of the Area*
PS-P09	Changhwan OH	*Re-examination of Anatomical Features of Fossil Woods Reported by Jefferson et al. (1983) at Mesa Range, Northern Victoria Land, Antarctica and Consideration of Taphonomical process*
PS-P10	Jihwan PARK	*Predicting the Impact of Lava Flows at Mt. Melbourne*
PS-P11	Taehwan KIM	*2014 Geological Field Survey on the Wilson Terrane Lithologies Near the Jang Bogo Station, Northern Victoria Land, Antarctica, and the Preliminary Study on Eclogite-Facies Metamorphic Rocks from the Lanterman Range*
PS-P12	Jeong HAN	*Petrography, Geochemistry, and Age of a Granophyre Clast in the Lunar Meteorite Dew 12007*
Remote Sensing of the Changing Globe I (Marine), II (Terrestrial) (PS-S00)		

PS-S01	Chang-Sin KIM	*Variability of the Antarctic Coastal Current and its Causes in the Amundsen Sea*
PS-S02	Ho Kyung HA	*Variability of ADCP Backscattering Signals Captured by Long-Term Moorings: Amundsen Shelf, Antarctica*
PS-S03	Young-Heon JO	*Temporal and Spatial Variability of Ross Sea Polynya Using Multi-Satellite Observations*
PS-S04	Jang-Geun CHOI	*Characteristic of Antarctic Circumpolar Current Around the Ross Sea*
PS-S05	Christopher J. ZAPPA	*High Salinity Shelf Water Formation in Response to Atmospheric Forcing of The Terra Nova Bay Polynya, Antarctica*
PS-S06	Christopher J. ZAPPA	*Marginal Ice Zone Processes Observed from Unmanned Aerial Systems*
PS-S07	Byongjun HWANG	*Remote Sensing Efforts in ONR MIZ Project*
PS-S08	Jeong-Won PARK	*Surface Melting of Sea Ice and Melt Pond Observed by Spaceborne High-Resolution Imaging Data*
PS-S09	Jinyoung JUNG	*Nutrients in Melt Ponds and Snows on Arctic Sea Ice During 2014 Sea Ice Camp*
PS-S10	Jinyoung JUNG	*Biogeochemical Characteristics of Nutrients, Dissolved and Particulate Organic Matters in the Amundsen Sea*
PS-S11	Keyhong PARK	*Estimation of Net Community Production in the Amundsen Sea Polynya: Self-Organizing Map Analysis Approach*
PS-S12	Keyhong PARK	*Source Characterization of Carbon Monoxide and Ozone Over the Northwestern Pacific in Summer 2012*
PS-S13	Minkyoung KIM	*Sinking Particle Flux and Organic Carbon Sedimentation on the Amundsen Shelf, Antarctica*
PS-S14	Intae KIM	*The Distribution of Glacial Meltwater in the Amundsen Sea, Antarctica, Revealed by Excess Helium and Neon*
PS-S15	Liqi CHEN	*Ocean Acidification Observation Network for the Arctic and Sub-Arctic Pacific Oceans*

PS-S16	Suqing XU	*Sea-Air CO2 Fluxes in the Southern Ocean for the Late Spring and Early Summer in 2009*
PS-S17	Young Shin KWON	*Contrasting Co Cycles in the Surface Mixed Layer Between the North Pacific and the Amundsen Sea*
PS-S18	Sun-Yong HA	*Strategy of Photo-Protection on Phytoplankton Assemblages in the Kongsfjorden, Svalbard, Arctic*
PS-S19	Eun Jae KIM	*Growth and Lipid Formation of Arctic Microalgae Chlamydomonas sp. ArM0029C*
PS-S20	Yoon Chang LEE	*Taxonomic Variability of Phytoplankton and Relationship with Production of CDOM in the Polynya of the Amundsen Sea, Antarctica*
PS-S21	Hyoung Sul LA	*Diel Vertical Migration of Arctic Copepods Under Sea Ice in the Canada Basin*
PS-S22	Chang-Uk HYUN	*Penguin Counting Using UAV Imaging and Object Based Image Analysis*
PS-S23	Pawan KUMAR BHARTI	*Occurrence of Various Ingredients in the Aquatic Environments of Two Lakes at Stornes Peninsula, Larsemann Hills, East Antarctica*
PS-S24	Sora SEO	*Temporal Variation of Tropospheric Ozone and Springtime Ozone Depletion Events at King Sejong Station, Antarctica*
PS-S25	Minji SEO	*Long-Term Variability Observation of Albedo and its Relationship with Surface Temperature Over Antarctica*
Arctic, Biology and Other Related (PS-B00)		
PS-B01	Kai KÜNNIS-BERES	*Role of Bacteria in Mobilization of Major and Track Elements in Polar Rocky Soils Under Condition of Climate Warming*
PS-B02	Sungjin NAM	*Soil Organic Matter, Bacterial Community Structure and Soil Properties of a Moist Acidic Tussock Tundra in Council, Alaska*
PS-B03	Hye Ryeon GYEONG	*Domibacillus tundrae sp. nov., Isolated from Active Layer Soil of Tussock Tundra in Council, Alaska*
PS-B04	Ki Heon PARK	*Isolation and Identification of Anaerobic Bacteria from Arctic Tundra Soils*

PS-B05	Do-Hwan AHN	*Transcriptome Analysis and Discovery of Induced Immune Response Genes by Pathogen Agonist in the Antarctic Bullhead Notothen Notothenia Coriiceps*
PS-B06	Jae Eun SO	*A Study to Select the Diagnostic Morphological Characters to Identify the Species in the Cladonia Gracilis Group*
PS-B07	Kyuin HWANG	*Careless Preprocessing Make Critical Bias at Microbial Community*
PS-B08	Changwoo LEE	*Structural and Binding Properties of Two Fatty Acid-Binding Proteins from Gentoo Penguin*

Associated Meetings

May 18 (Monday)	
Sessions	**Climate Change and Terrestrial Research in the Arctic** *Seminar room (Main Building 3F, 1301)*
15:00 - 15:15	**Sang-Jong PARK** ***Variability of Summertime Surface Energy Components at an Alaska Tundra Site***
15:15 - 15:30	**Petr BOGORODSKII** ***Arctic Permafrost Seasonal Thawing Dynamics (Observation and Modelling Approach)***
15:30 - 15:45	**Alexander MAKAROV** ***Terrestrial Paleoenvironmental and Permafrost Studying in the Russian Arctic***
15:45 - 16:00	***Coffee Break***
16:00 - 16:15	**Ji Young JUNG** ***KOPRI Research Activities in Arctic Soil Organic Matter***
16:15 - 16:30	**Rhiannon MONDAV** ***Microbial Dynamics of a Thawing Palsa Mire: An Indicator Species and Ecosystem***
16:30 - 16:45	**Dominique LAFFLY** ***From the Point to the Surface: How Bayesian Probabilities Are Used to Spatialize Soil Organic Carbon***
16:45 - 17:00	**Jun UETAKE** ***Formation processes of Cryoconite Granules in North Western Greenland***
17:00 - 18:00	***Discussion***

SOCIAL EVENTS

All participants are kindly invited to the social events hosted by KOPRI. Please mark it when you make a registration at the symposium website (http://symposium.kopri.re.kr).

Icebreaker	Banquet
May 18, 18:00 - 20:00	May 20, 18:00 - 20:00
Orakai Songdo Park Hotel	KOPRI Hall

FOR POLAR EARLY CAREER SCIENTISTS

KOPRI wishes to encourage the participation of early career scientists at this symposium.

KOREAN Early Career Scientists Gathering

Date & Time : May 20th, 12:00-13:20
Meeting Place : Seminar Room(KOPRI Main Building 3rd Floor)

Young Scientist Awards

Young Scientist Awards will be presented to the outstanding poster presentations and the award ceremony will take place as a part of the banquet on May 20th.

For further information, please contact the symposium secretariat or visit the symposium website (http://symposium.kopri.re.kr).

TRANSPORTATION INFORMATION

Between Incheon International Airport and Songdo Hotels

If you are staying at either the Oakwood Premier Incheon Hotel or 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 symposium website: https://symposium.kopri.re.kr/docs/ISPS2015_transportation_guide.pdf

Between Orakai Songdo Park Hotel and KOPRI

A shuttle bus between the Orakai Songdo Park Hotel and KOPRI will be provided during May 19-20. The shuttle bus will also stop at the BIT Zone Station (Incheon Subway Line 1). You can find the time table below;

Hotel	BIT Zone Station (Exit #2)	KOPRI
08:20	08:30	08:40

KOPRI	BIT Zone Station (Exit #3)	Hotel
18:30	18:40	18:50
20:10*	20:20	20:25

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

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PLENARY LECTURE

A ROADMAP FOR ANTARCTIC AND SOUTHERN OCEAN SCIENCE FOR THE NEXT TWO DECADES AND BEYOND

Mahlon C. Kennicutt II[1]

[1]*Texas A&M University College Station, TX, U.S.A*

mckennicutt@gmail.com

ABSTRACT

Antarctic and Southern Ocean science has been, and will continue to be, vital to understanding natural variability, the processes that govern change and the role of humans in the Earth system. The potential for new knowledge from Antarctic science yet to be conducted is substantial. Recognizing this promise, the international Antarctic community came together to scan the horizon to identify the highest priority scientific questions that Antarctic researchers should aspire to answer in the next two decades and beyond. Wide consultation was a fundamental precept to developing a collective, international view of future directions in Antarctic science. From the many possibilities suggested, the Horizon Scan identified THE 80 most important scientific questions through methodical debate, discussion, revision and elimination by voting. Related questions were assembled into seven topical clusters: (i) "Antarctic Atmosphere and Global Connections" and (ii) "the Southern Ocean and Sea Ice in a Warming World" – questions that explore the behavior of the Antarctic atmosphere, ocean and sea ice as drivers of global climate and their connectivity to the Earth system, and improve climate predictions; (iii) "The Ice Sheet and Sea Level" – knowledge that will improve decadal- to century-scale forecasts of sea level, and more accurately portray "ice sheet-ice shelf" dynamics and sensitivities to atmospheric and oceanic forcing in models; (iv) "The Dynamic Earth beneath Antarctic Ice" – study of the deep-time history of Earth to improve understanding of plate tectonics, the evolution of life and the history of planetary ice, and validate climate, ice sheet and sea level models; (v) "Life on the Precipice" – exploration to better understand the interplay of evolutionary adaptation and ecological drivers crucial to forecasting biotic responses to change, and advance life sciences knowledge through censuses and process studies; (vi) "Near-Earth Space and Beyond - Eyes on the Sky" – observing space from Antarctica to develop unique insight into the origins and structure of the universe, the nature of Dark Universe, the evolution of galaxies, the birth of stars, and the dynamics of the ionosphere, and to identify planets capable of sustaining life; and (vii) "Human Presence in Antarctica" – research to better understand the impacts of humans in Antarctica, and the challenges this presents to governance regimes.

Answering these questions will require innovative experimental designs, new applications of technology, invention of next generation field and laboratory methodologies and development of innovative observing systems and networks. Unbiased, non-contaminating procedures will be required to retrieve the requisite air, biota, sediment and rock, ice and water samples under challenging conditions. Sustained year-round, access to Antarctica and the Southern Ocean will be essential. Improved models are needed that realistically represent Antarctica and the Southern Ocean as an integral part of the Earth system, and provide predictions at spatial and temporal resolutions that support

decision-making. A coordinated, portfolio of cross-disciplinary and bipolar science, based on new models of international collaboration and funding, will be essential as no one scientist, program or nation can realize these aspirations alone.

BOTTOM WATER EXPORT FROM THE WESTERN ROSS SEA

Arnold L. Gordon[1] and Christopher Zappa[1]*

[1] Lamont-Doherty Earth Observatory of Columbia University, Palisades, NY 10964, USA

ABSTRACT

Within the Ross Sea, high salinity shelf water (HSSW), derived primarily through air-sea interaction within the Terra Nova Polynya, is eventually exported via the Drygalski Basin, into the deep ocean contributing to the globally important Antarctic Bottom Water. Bottom water export from the Ross Sea, February 2007 to January 2011 exhibits seasonal and interannual variability. Temperature minima coupled to salinity maxima in late austral summer, into the fall, indicate input HSSW. Secondary temperature minima lacking the high salinity trait, characteristic of low salinity shelf water (LSSW) formed in the interior of the Ross Sea, appear in the spring. Warmer bottom water similar to modified circumpolar deep water (mCDW) is observed in winter and in early summer. The LSSW and mCDW may also be drawn from the Drygalski Basin, as the HSSW pool retreats poleward from the shelf break in response to increased winter polar easterlies allowing these less dense overlying waters to spill into the deep ocean within the benthic layer. Bottom salinity decreased from 2007 to 2011 by 0.007 psu/year, significantly higher than regional decadal trends, which we propose is a result of HSSW retreat induced by polar easterlies strengthening.

INVITED LECTURE

JAPAN'S POLAR RESEARCH: A FUTURE DIRECTION

Kazuyuki Shiraishi

National Institute of Polar Research, Japan

ABSTRACT

Modern Japan's Polar research was initiated in Antarctica during IGY (1957-58). The first Japanese Antarctic Expedition (JARE) established Syowa Station in Ongul Island in eastern Dronning Maud Land and started wintering observation for meteorology, geophysics, geology and upper atmospheric physics. Since then, Syowa Station grew to the one of the hub stations in Antarctica for global geophysical observatory network. Later JARE has established three more stations in inland areas including Dome Fuji Station at the 3810m a.s.l. where glaciologists collected deep ice core samples of >3000 m deep. The Japanese Antarctic Program is planned every 6 years as a mid-term program and now the ninth mid-term program (2016-2021) is under consideration.

The Arctic research in Japan initiated 1950's by various teams of universities. Though Japan is a very early member of IASC, the systematic national program started recently as Arctic Climate research Project 2011-2015 of Green Network of Excellence Program. Now the next phase of the national program is planned.

In this talk, I will briefly present our research plans in both the Antarctic and the Arctic in near future.

SESSION

Lower and Upper Atmospheric Research in the Polar Region

HIGHLIGHTS OF RECENT AND FUTURE POLAR UPPER ATMOSPHERIC SCIENCE IN FINLAND

Esa Turunen

Esa Turunen[1, 2], Richard Fallows[1,3], Antti Kero[1], Leon Kocharov[1], Alexander Kozlovsky[1], Sari Lasanen[1], Markku Lehtinen[1], Jyrki Manninen[1], Derek McKay-Bukowski[1], Mikko Orispää[1], Stepan Poluianov[4], Tero Raita[1], Lassi Roininen[1], Thomas Ulich[1], Ilya Usoskin[1], Juha Vierinen[1,5], Ilkka Virtanen[1]

[1]Sodankyla Geophysical Observatory, University of Oulu, Finland
[2] Solar-Terrestrial Environment Laboratory, Nagoya University, Japan
[3]Netherlands Institute for Radio Astronomy, Dwingeloo, Netherlands
[4]Faculty of Science,University of Oulu, Finland
[5]MIT Haystack Observatory, Westford MA, USA

esa.turunen@sgo.fi

ABSTRACT

Sodankyla Geophysical Observatory (SGO) of University of Oulu, Finland, has carried out geophysical measurements and related research at high latitude in the Arctic for more than 100 years now. One of the main research interests of SGO is the influence of solar forcing on climate and weather. Here ultimately measurements of phenomena and couplings in the polar geospace and atmospheric environment are needed in both polar regions. SGO recently entered the category of institutes, which have instrumentation both in the Arctic and Antarctic, since continuous operation of a newly constructed neutron monitor in Antarctic started in January 2015. A special expertise of SGO is remote sensing of the upper atmosphere by radio methods. New software-defined-radio type of instruments have been utilized in modernizing geophysical instrumentation. An example of this is the Kilpisjarvi Atmospheric Imaging Receiver Array, KAIRA facility, which is Finlands's largest radio telescope but also serves as a platform to develop EISCAT_3D type radar reception by simultaneous multiple beams and world-wide new instrumental methods, such as for example the interferometric wide-band imaging riometry, where maps of energy characteristics of the precipitating high energy particles will be the final data product. SGO also carries out instrument development to support observation networks with low power and reliable but modern hardware, including SDR products. Global change related issues can be studied also based on upper atmospheric measurements. SGO has been running an ionospheric vertical sounder since 1957 and the data was used to study the expected long-term cooling of the thermosphere. Currently SGO has developed a small version of SDR-based receiver for its ionospheric chirp sounder and the idea is to make mapping of ionosphere in larger spatial scales by oblique soundings with a network of these receivers. SGO also actively participates in developing the next generation incoherent scatter radar EISCAT_3D, which is a phased-array facility with several tens of

thousands of antennas, to be distributed in 5 stations across 3 countries in Northern Scandinavia. EISCAT_3D will be a vector imaging radar studying the geospace and atmospheric environment, supporting studies of couplings between space environment and atmospheric layers at the southern edges of the polar vortex and auroral oval.

GRAVITY WAVES AT HIGH LATITUDES FROM HIGH RESOLUTION WACCM SIMULATIONS

Han-Li Liu[1]

[1]*High Altitude Observatory, Nantional Center for Atmospheric, Boulder, Colorado, USA*

liuh@ucar.edu

ABSTRACT

Gravity waves play a key role in the vertical coupling of atmosphere regions, because they can impact large-scale flow, induce transport of atmosphere constituents, and cause increasingly large atmospheric perturbations at higher altitudes, including the thermosphere and ionosphere. The wave impact can be in particular significant at high latitudes in the middle and upper atmosphere. At the same time they also pose a stiff challenge to the study of vertical coupling, because of the very broad range of spatial and temporal scales of these waves. In global models using the traditional latitude and longitude grid, the gravity waves at higher latitudes are often strongly damped due to the application of polar filter to maintain numerical stability. Recently we have performed Whole Atmosphere Community Climate Model (WACCM) simulations at ~0.25 degree horizontal and 0.1 scale-height vertical resolution using cubed-sphere. I will present results from this simulation. Gravity wave quantities will be compared with observational and numerical studies, including wave energy density and their spatial distribution, and wave forcing in the middle and upper atmosphere. The gravity waves at high latitudes, especially those associated with polar stratospheric jet and South American/Antarctica orography, will also be examined.

MONITORING AND EVALUATION OF SOLAR IRRADIANCE AT MENDEL STATION, NORTHERN ANTARCTIC PENINSULA

Kamil Láska

*Kamil Láska[1]**

[1]Department of Geography, Masaryk University, Brno, Czech Republic

laska@sci.muni.cz

ABSTRACT

Understanding the distribution of solar irradiance observed in high latitudes of the Southern Hemisphere is important for variety of effects and feedbacks in the marine and terrestrial ecosystems. Seasonal increase of the ultraviolet (UV) irradiance caused by a decrease of the stratospheric ozone concentration is a specific feature of solar radiation in Antarctica. Therefore, an intensive investigation has been carried out there of both the physical and chemical changes in the atmosphere, and the effects of rising UV radiation on polar ecosystems. Recent studies indicate that both atmospheric circulation and stratospheric temperature play an essential role in the extent of ozone losses over this continent (e.g. Hofmann et al., 2009). Apart from ozone, the solar UV irradiance is affected by a variety of environmental factors such as cloudiness, ground reflectivity (albedo), and aerosol loadings (Vitale et al., 2011). Since amount of aerosols in Antarctica is very low, the cloudiness is considered to be important factor reducing the UV irradiance reaching the ground. In contrast to central part of the continent (Antarctic plateau), the role of clouds is more important in the coastal and maritime regions (Láska et al., 2009).

In this contribution, long-term solar radiation data sets recorded at the Czech Johann Gregor Mendel Station (63°48'S, 57°53'W, 7 m above sea level) situated on the northern tip of James Ross Island are presented. James Ross Island is a relatively large island (2500 km^2) located off the eastern coast of the Antarctic Peninsula. Clouds and other atmospheric constituents are modified by an orographic barrier of the Antarctic Peninsula, which leads to significant differences between western and eastern coast. Therefore, solar radiation measurements at Mendel Station can provide important information to study effects of atmospheric factors on radiation fluxes (see Fig. 1). For the purpose of this study, short-wave incident (SW) radiation and erythemally weighted (EW) radiation were analyzed from October 2007 to January 2011. The measurements were carried out by a CM11 pyranometer (Kipp&Zonen, The Netherlands), and a broadband UV-Biometer Model 501A (Solar Light, USA). The measured EWR represents a solar irradiance weighted by the erythemal action spectrum according to McKinlay and Diffey (1987). The total ozone content was obtained from the Ozone Monitoring Instrument (OMI, 2015) operational retrievals for the geographical coordinates of Mendel Station.

The statistical analysis and nonlinear regression model (Láska et al., 2010) supported the fundamental influence of the cloudiness and ozone on the variation of SW and EW irradiances. The effect and significance of these factors, however, differed from year to year due to the patterns of

atmospheric circulation, stratospheric temperature and development of ozone depletion in early spring period. The analysis confirmed that, due to changes in solar elevation angle and total ozone content, the highest SW irradiances occured in December and January, while EW irradiances could be found in the second half of November. Maximum daily EW irradiance was observed on 18 November 2007 (5.968 kJ m^{-2}) and 24 November 2008 (6.655 kJ m^{-2}), respectively. In conclusion, it can be stated that a high day-to-day variability of total ozone content and cloudiness may create large differences between measured and predicted EW irradiances by using nonlinear regression model. The largest EW residuals exceeded ± 0.25 kJ m^{-2} during rapid ozone decline, however, represented less than 2% of all cases.

Fig. 1 The Kipp & Zonen radiometers and the Solar Light UV-Biometer Model 501A installed at Mendel Station on James Ross Island, northern Antarctic Peninsula.

Acknowledgments

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INVESTIGATION OF CLIMATE CHANGE MECHANISM BY OBSERVATION AND SIMULATION OF POLAR CLIMATE FOR THE PAST AND PRESENT

Seong-Joong Kim, Soon-Do Hur, Sang-Bum Hong, Heejin Hwang, Jung-Ho Kang, Yeongcheol Han, Sang-Jong Park, Taejin Choi, Young-Jun Yoon, Baek-Min Kim, Joo-Hong Kim, Geonhwa Jee, Jeong-Han Kim*

Korea Polar Research Institute, Korea

seongjkim@kopri.re.kr

ABSTRACT

The Arctic warming is 2-3 times faster than that of low latitudes and associated sea ice reduction is remarkable, especially in summer. In late autumn, the less sea ice freezing in the Kara-Barents Seas leads to a huge transfer of heat from the ocean to atmosphere, activating large-scale planetary wave propagation to upper levels. The enhanced upward propagation together with heat flux from ocean to atmosphere increases temperature and pressure over the Arctic, weakening the polar vortex. This provides favorable conditions for cold Arctic air to propagate down to mid-latitudes. The climate change over Antarctica is different from that of the Arctic. As in the Arctic, a marked warming occurs in west Antarctica, especially the Amundsen Sea sector where sea ice and ice sheet are melting more rapidly than the rest region. However, in east Antarctica, a slight cooling has occurred and ice sheet and sea ice are increasing slightly.

In order to investigate the climate change mechanism in both the Arctic and Antarctica, we reconstruct past climate and environment records using Greenland and Antarctic ice cores, quantify the degree of climate change through in-situ atmospheric observations, and reproduce polar climate change using various kinds of numerical models. To reconstruct the past climate and environment, we drilled ice cores at GV7 site located at George V Land, Antarctica, in cooperation with Italian ice coring team. We analyzed climate and environment records from the Greenland NEEM ice core. To quantify the degree of climate change and atmospheric environment, we installed atmospheric equipment such as AWS, flux towers, CCN counter, etc., at the King Sejong Station in the Antarctic Peninsula, the Lyndsy Island in the Amundsen Sea, and the Jangbogo Station in the Terra Nova Bay. We adopt various numerical models from regional to global scales and from sea ice to upper atmospheres and reproduce polar climate by utilizing the field observation data. We attempt to find the coupling mechanism between lower atmosphere and upper atmosphere teleconnection using both in-situ observation data and numerical models.

In this study, several important results have been obtained. First, we found out that the mid-latitude cold surges in recent decades are, in part, associated with the weakening of stratosphere polar vortex caused by sea ice reduction over the Kara-Barents Seas using the 5th version of NCAR Community Atmosphere

Model. This result has the meaning that the rapidly melting sea ice in the Arctic contributes to the weakening of the polar vortex, besides the increase in snow cover over Siberia. Second, we investigated that the Southern Annular Mode, which is an index of mass oscillation between Antarctica and mid-latitudes, was weaker during the Last Glacial Maximum, indicating that in the future under global warming the southern hemisphere westerly winds could be stronger than present. Third, the isotopic compositions of oxygen and hydrogen from the GV7 snowpit and oxygen isotope ratio of the Greenland NEEM ice core were analyzed. Fourth, we observed and analyzed heat flux between surface and atmosphere and aerosol concentrations in the King Sejong Station and found out that the heat fluxes depend on the surface conditions. Finally, we investigated the relation between the polar vortex variability and the upper atmosphere temperature using both the ground-based and satellite observations. The result shows that during a sudden stratospheric warming event there tend to be strong correlations between stratospheric temperature and upper atmospheric temperatures.

ARCTIC RESEARCH COLLABORATION FOR RADIOSONDE OBSERVING SYSTEM EXPERIMENT (ARCROSE)

Jun Inoue[1,2]*

[1]*National Institute of Polar Research, Japan*
[2]*Japan Agency for Marine-Earth Science and Technology, Japan*

inoue.jun@nipr.ac.jp

ABSTRACT

The Arctic Research Collaboration for Radiosonde Observing System Experiment (ARCROSE) has been initiated since 2013 fall. This project consists of the intensified Arctic sounding network and data assimilation researches. The four Arctic stations (Ny-Å lesund: 6 launches per day, Alert & Eureka: 4 launches per day, and the R/V Mirai: 8 launches per day) made special sounding dataset during the 2-week campaign period in September 2013. All of data were sent to GTS, likely improving the accuracy of forecasting and reanalyses data over the Arctic Ocean when compared with other years. The effect of the ARCROSE observations on numerical simulation will be evaluated by using a data assimilation technique to propose a future observing network, leading to a better understanding of the uncertainty of the Arctic atmospheric circulation. The project is expanded in September 2014 in collaboration with the R/Vs Oden and Polarstern. The activity contributes to the preparation phase of the Year of Polar Prediction (YOPP) in 2017/2018, which is intended as intensive observational and modeling periods to advance polar prediction capabilities.

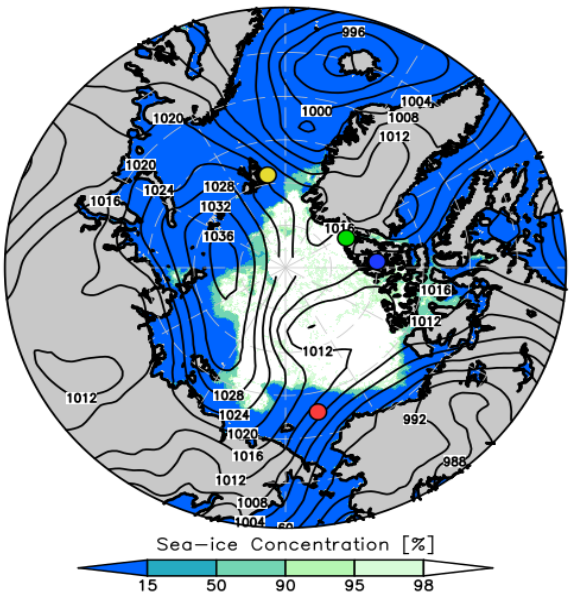

Figure 1 | SLP and SIC on 21 September 2013. The ARCROSE stations are indicated by dots (red: RV Mirai, yellow: Ny-Å lesund, green: Alert, and blue: Eureka). Sea level pressure (SLP: hPa) and sea-ice concentration (SIC: %) data are taken from ERA-Interim and AMSR-2 satellite, respectively.

SESSION

Reconstruction of Past Climate Records and Environment Records

NEW DIRECTIONS FOR ICE CORE RESEARCH IN ANTARCTICA

Edward Brook[1]

[1]*College of Earth, Ocean and Atmospheric Sciences, Oregon State University, Corvallis, OR USA*

brooke@geo.oregonstat.eedu

ABSTRACT

Polar ice cores are powerful tools for reconstructing past changes in Earth′s climate and environment. They provide critical insight into climate forcing, natural climate variability, global biogeochemical cycles, and tests of regional and global climate models under a wide range of conditions. Despite the significance of existing records there is much more to learn by new coring in critical areas with existing and new methods, and applying and developing new measurement techniques. This presentation will review recent developments and discuss possible new directions.

Priorities outlined by International Partnerships in Ice Core Sciences (IPICS) provide a broad roadmap for developing detailed understanding of climate and environmental change over the last 2,000 and 40,000 years, and a new focus on the last interglacial period. In addition, a major IPICS goal is to obtain an ice core record extending back to 1.5 million years (the IPICS Oldest Ice Project).

New ice coring in East Antarctica could make major contributions to IPICS 2K, 40K and the last interglacial project by increasing spatial data coverage to understand regional patterns of environmental change on a variety of time scales. A record covering the last 1.5 million years would answer questions about why the major frequency of climate variability changed from 40 ka to 100 ka about 1 million years ago, but site selection and exploration is still needed to locate the right coring sites.

New analytical techniques can bring an additional dimension to ice core data. Recent advances in continuous analysis, including gases, isotope ratio measurements of species in the ice and gas records, and new dating methods and environmental tracers add significant value to ice core records.

Drilling technology is also evolving and an area where much further improvement is possible. Development of replicate coring, new in situ probes, and rapid access drilling by several research groups will increase the pace of discovery.

Finally, significant progress on extracting past environmental information from blue ice regions has been made, and it is likely that further exploration of blue ice regions will allow the possibility of sampling large ice volumes from a variety of time periods, as well as possibly provide access to very old ice.

CHARACTERISTICS OF ENVIRONMENTAL SIGNALS IN SOLID PRECIPITATION, SURFACE SNOW AND DEEP ICE CORE AT DOME FUJI, ANTARCTICA

Hideaki Motoyama

Hideaki Motoyama[1,2],and Dome Fuji Ice Core Project members[1]*

[1] National Institute of Polar Research, Tokyo Japan
[2]SOKENDAI (The Graduate University for Advanced Studies), Tokyo Japan

motoyama@nipr.ac.jp

ABSTRACT

Two deep ice cores (DF1: 2503m, DF2: 3035m) at Dome Fuji, Antarctica have the in-depth information on global environmental change from present to the past 700,000 years. We made the data set of major ion concentration, dust concentration and stable isotope ratio which were analyzed 10cm sample every 50cm from 2400m to 3035m using the DF2 core. The age of this depth was covered from 300,000 to 70,000 years before. Using the DF1 core, major chemical species were carried out using 7-10cm ice samples cut out of the 50 cm-long spaced from 0.5 to 2.5m. All data was averaged by every 5 m or every 1,000 years.

The indexes of climate and environment are the following elements; MSA^-, Cl^-, NO_3^-, SO_4^{2-}, H^+ (calculated from pH), Na^+, Mg^{2+}, Ca^{2+}, dD, $d^{18}O$, d-excess, dust. Generally, there is a feature in correlation respectively by the climatic stage. dD or $d^{18}O$ which becomes the index of the temperature and the environmental elements (for example, Na^+ and Mg^{2+}) indicate the strong negative correlation, but its degree is different depending on the climatic stages. Especially, warming events (AIM, inter-glacial stage) are studied with different time scale.

Time scales of our studies are daily, yearly, decadal, few hundred and millennial-scales and glacial-interglacial cycle. Deep ice core records are compared with initial conditions (precipitation and surface snow). We show the difference of the chemistry of surface snow by the difference of the snow type in the same area.

The amplitude of the variation of the signal becomes small from surface snow to ice. The average value of snow is inter-glacial stage level. By the way, the concentration of nitrate decreased from the snow surface as you know. Calcium and nitrate has no correlation in surface snow but they have a strong correlation in the ice core.

ELEMENTAL AND PB ISOTOPIC EVIDENCE FOR DIFFERENT INTERGLACIAL CLIMATES BEFORE AND AFTER THE MID-BRUNHES EVENT (~430 KYR BP) IN THE EPICA DOME C ICE CORE

Sungmin Hong[1], Changhee Han[2], Soon Do Hur[2], Hee Jin Hwang[2], Laurie J. Burn-Nunes[3], Tseren-Ochir Soyol-Erdene[4], Paolo Gabrielli[5], Carlo Barbante[6], Claude F. Boutron[7]*

[1]Department of Ocean Sciences, Inha University,100 Inha-ro, Nam-gu, Incheon 402-751, Korea
[2]Korea Polar Research Institute, Songdomirearo 26, Yeonsu-gu, Incheon 406-840, Republic of Korea
[3]Department of Imaging and Applied Physics, Curtin University of Technology, GPO Box U1987, Perth 6845, Western Australia, Australia
[4]School of Chemistry and Chemical Engineering, National University of Mongolia, Ulaanbaatar, Mongolia
[5]School of Earth Sciences and Byrd Polar Research Center, The Ohio State University, Columbus, Ohio, USA.
[6]Department of Environmental Sciences, University of Venice, Venice, Italy
[7]Laboratoire de Glaciologie et Géophysique de l'Environnement, UMR CNRS 5183, Saint Martin d'Hères Cedex, France

smhong@inha.ac.kr

ABSTRACT

We present here preliminary data on past changes in the occurrence of various trace elements and Pb isotopic composition in the European Project for Ice Coring in Antarctica (EPICA) Dome C ice core over the time period between Marine Isotope Stage (MIS) 15, ~570 kyr BP, and MIS 20.2, ~800 kyr BP. Our data profiles are compared with those available along the EPICA Dome C ice core back to ~200 kyr BP to characterize climate-related natural changes in concentrations and fluxes of these elements and Pb isotopic composition. Concentrations and fluxes of most of elements were observed to be highly variable with higher values during glacial maxima and lower values during warmer periods. Crustal enrichment factors suggest various sources for the different elements. The contribution from volcanic emissions appears to be very important for most of trace elements when climatic conditions become warmer. Pb isotopic compositions also show variations with changing climate due to relative proportions of dust and volcanic Pb. The results demonstrate that a natural variability of elemental and Pb isotopic compositions are strongly linked to climatic conditions during interglacial periods before and after the Mid-Brunhes Event (~43 kyr BP). Finally, our data indicate that human activity has induced the greatest perturbation of the atmospheric cycles of these elements ever experienced over a period of ~800 kyr in the remotest area on Earth.

THRESHOLD RESPONSE OF THE ANTARCTIC ICE SHEET TO ATMOSPHERIC CO_2 VARIABILITY DURING THE EARLY TO MIDDLE MIOCENE

Richard Levy

Richard Levy[1], David Harwood[2], Fabio Florindo[3], Hilmar von Eynatten[4], Christopher Fielding[2], Nicholas Golledge[1,5], Gerhard Kuhn[6], Robert McKay[5], Timothy Naish[5], Matt Olney[7], Francesca Sangiorgi[8], Sophie Warny[9], and SMS Science Team.*

[1]*GNS Science, Lower Hutt, New Zealand*
[2]*University of Nebraska-Lincoln, Lincoln, NE, USA*
[3]*Istituto Nazionale di Geofisica e Vulcanologia, Rome, Italy*
[4]*Geoscience Center Göttingen (GZG), Göttingen, Germany*
[5]*Victoria University of Wellington, Wellington, New Zealand*
[6]*Alfred Wegener Institute, Bremerhaven, Germany*
[7]*Hillsborough Community College, Tampa, FL, USA*
[8]*Universitat Utrecht, Utrecht, Netherlands*
[9]*Louisiana State University, Baton Rouge, Louisiana, USA*

r.levy@gns.cri.nz

ABSTRACT

The Early to early Middle Miocene (20.2 to 14.5 million years ago) offers a compelling interval to study linkages between climate change and ice sheet dynamics as geographic boundary conditions were broadly similar to present and atmospheric CO_2 concentrations were analogous to those projected for the next several decades. Furthermore, this interval of time includes the Miocene Climatic Optimum (MCO), a period of global warmth during which average surface temperatures were 3 to 4℃ higher than today. Geological records at locations proximal to the Antarctic margin offer direct information regarding ice sheet variability through this key interval in Earth's climatic history and offer insight into Antarctica's potential contribution to future sea level rise. Here, we report new results from a 1138-meter sediment core (AND-2A) recovered from the Southern McMurdo Sound sector of the Ross Sea that contains a record of environmental change through the Miocene. Our multi-proxy dataset identifies four distinct environmental "motifs" identified by changes in sedimentary facies, fossil assemblages, and geochemical indicators of provenance, weathering and paleotemperature. Our paleoenvironmental reconstructions highlight a highly variable climate and glacial regime, ranging from large-scale glacial expansion of marine based ice sheets, to warmer climates where ice sheet margins had retreated inland from the coastline. Three distinct intervals of extensive glacial retreat indicate surface air temperatures were warm enough for significant ice surface melt at times when greenhouse gas levels were only slightly higher than today. The near-continuous stratigraphy in AND-2A is interrupted by four major

disconformities that coincide with regionally mapped seismic discontinuities and reflect transient expansion of marine-based ice across the Ross Sea. The timing of these major marine-based ice sheet advances correlates with shifts in highly-resolved deep sea isotope records and major drops in eustatic sea-level, indicating the global nature of these events. Results suggest that polar climate and the margins of the Antarctic Ice Sheet (AIS) are highly sensitive to relatively small changes in CO_2, and that a critical threshold between 350-400 ppm controls the growth and retreat of marine-based ice sheets.

CHANGE IN DEEP WATER CIRCULATION IN SOUTHERN DRAKE PASSAGE DURING THE MID-PLEISTOCENE TRANSITION

*Jae Il Lee *, Kyu Cheul Yoo, Heung Soo Moon and Ho Il Yoon*

Korea Polar Research Institute, Incheon, Korea
sleeji@kopri.re.kr

ABSTRACT

Seven gravity cores (2.5~8-m long) from southern Drake Passage were analyzed for magnetic susceptibility, grain size distribution, total organic carbon, and total inorganic carbon content to reconstruct paleoceanographic changes in late Quaternary. Glacial sediments from southern Drake Passage are distinguished from interglacial sediments by their higher magnetic susceptibility and lower total organic carbon, due to the increased influx of magnetic minerals from nearby source areas (South Shetland Islands and northern Antarctic Peninsula) during glacial periods and increased marine productivity during interglacial periods. Correlation among the cores based on magnetic susceptibility indicates that sedimentation rates are higher in northeastern cores than in southwestern cores. Northeastern cores record paleoceanographic changes since the last glacial period, whereas a southwestern core of the lowest sedimentation rate show records of last ~900 thousand years. Carbonate content is higher in interglacial sediments than in glacial sediments prior to mid-Pleistocene transition (MPT), reflecting higher productivity during interglacial periods. Since the MPT carbonate dissolution occurs widely, and carbonates are preserved only in some glacial sediment. Absence of carbonate in post-MPT interglacial sediments suggests an invasion of corrosive deep water, possibly from Weddell Sea, since the MPT. Influence of Weddell Deep Water decreased during glacial periods due to extensive ice sheets and weakened current from the Weddell Sea, and carbonates are preserved in some post-MPT glacial sediment.

SESSION

Planetary Geology and Geological Evolution of the Victoria Land: Reviews and New Views

THE TECTONIC FRAMEWORK OF NORTHERN VICTORIA LAND IN THE PALEOZOIC: PRESENT STATUS AND OUTSTANDING PROBLEMS

John D. Bradshaw

Department of Geological Science, University of Canterbury, Private Bag, Christchurch New Zealand

ABSTRACT

In the Early Paleozoic Antarctica and Australia lay on the active convergent margin of the Gondwana continent. However, simple closing of the younger oceans by removal of Late Mesozoic and Cenozoic ocean floor does not restore Early Paleozoic rocks to a reasonable pattern and suggests complex pre-break-up tectonics. The character and timing of these tectonic events are not yet resolved.

The Paleozoic rocks of northern Victoria Land have been divided into three terranes. In the west the Wilson Terrane was an active continental margin in the Cambrian with an assemblage of Late Precambrian metamorphic rocks and Cambrian granites. The central Bowers Terrane is a remnant of a Cambrian volcanic arc to back-arc basin assemblage but the narrowness of the terrane indicates that it is very incomplete. Together, these two terranes form part of the Cambrian Ross Orogen of Antarctica, with correlatives in Australia. To the east, the Robertson Bay Terrane is an extensive belt of turbidites, probably of Late Cambrian and Ordovician age. It is suggested that these are better considered part of the Ordovician to Devonian Lachlan Orogen rather than the Ross Orogen. Correlatives of all three terrane have been recognized in New Zealand but the arrangement appears to be a mirror image of that in Antarctica.

Within this broad synthesis there are many uncertainties, particularly the history of the fault zones that bound the terranes. The affinities of the deformed rocks within these fault zones need further study together with the history of deformation. The granites of the Wilson Terrane correlate with other Cambrian granites of the Ross Orogen and they also appear as clasts in Late Cambrian conglomerates of the Bowers Terrane indicating proximity of the Bowers basin to the rising Wilson Terrane in the Late Cambrian. How much Cambrian deformation occurred in the Bowers Terrane is not clear, although there is evidence of erosion prior the deposition of the very thick Camp Ridge Quartzite. The latter is usually stated to be late Cambrian to Ordovician but we do not really know the age. It could be Silurian, though it is clear that it and the main deformation pre-date the Devonian granites that cut both the Robertson Bay Terrane and the Bowers Terrane. The age of the granites themselves is also poorly constrained.

PERMIAN AND TRIASSIC SEDIMENTATION IN THE CENTRAL TRANSANTARCTIC MOUNTAINS, SOUTHERN VICTORIA LAND AND NORTHERN VICTORIA LAND: A SOUTH POLAR VIEW OF GONDWANA DURING THE PALEOZOIC-MESOZOIC TRANSITION

John L. Isbell

*John L. Isbell[1]**

[1]*Department of Geosciences, Univ. of Wisconsin-Milwaukee, Milwaukee, WI, USA*

jisbell@uwm.edu

ABSTRACT

Throughout the central Transantarctic Mountains (CTM), thick Permian (up to 1.3 km thick) and, where preserved, thick Triassic strata (up to 1 km thick) occur. These strata were deposited in an evolving basin that changed from a narrow, possibly fault-bounded basin in the Early Permian, to an under-filled foreland basin during the Middle and Upper Permian, to an over-filled foreland basin in the Triassic (Collinson et al., 1994; Isbell et al., 1997). In Southern Victoria Land (SVL), narrow basinal conditions may have prevailed to the end of the Permian before the basin became over-filled in the Early Triassic (Collinson et al., 1994; Isbell and Cuneo, 1996). Collinson and Kemp (1983) and Collinson et al., (1986) suggested that deposition in Northern Victoria Land (NVL) occurred within a similar narrow fault-bounded basin. However, subsidence and uplift associated with the formation of this basin and how it may have influenced late Paleozoic sedimentation is unknown.

Late Paleozoic glacigenic strata occur throughout CTM (Metschel Tillite, Darwin Fm., Pagoda Fm., Scott Glacier Fm., and Buckeye Fm). There strata were deposited within at least two topographically expressed basins. A relatively small basin occurred in the Wisconsin and Ohio Ranges. However, the most laterally and stratigraphic continuous exposures in CTM were deposited in a trough-shaped basin that extended from the present Darwin Glacier to the Amundsen Glacier. Basement highs surrounded these basins and formed uplands onto which preglacial, glacial, and postglacial strata onlap. Examination of glacigenic units reveals that Permian strata were deposited as glaciomarine sediments within the two basins, and that subglacial diamictites and proximal glaciomarine sediments were deposited along basin margins (Isbell et al., 2008). Glacigenic strata in SVL are similar and consist of subglacial and proximal glaciomarine deposits including ice shove structures (Isbell, 2010).

In NVL, a 350-m-thick unnamed glacigenic succession of Upper Paleozoic diamictites, breccias (scree), conglomerates, cross-bedded sandstones, and shales occur in the western Lanterman Range. There, strata are faulted against basement rocks (Laird and Bradshaw, 1981; Skinner, 1981; Grindley and Oliver, 1983; McKelvey, 1983; McKelvey and Walker, 1983). Diamictite and breccia (~ 56 m thick)

also occur in the Morozumi Range and on Neall Massif (McKelvey, 1983; McKelvey and Walker, 1983; Collinson et al., 1986). The depositional setting of glacigenic and correlative strata in NVL is poorly documented, but early expeditions in the Lanterman Range suggested a plethora of depositional environments. Reconnaissance work by Laird and Bradshaw (1981) and Skinner (1981) suggested that the strata were deposited in subglacial, glaciofluvial, and ice-contact glaciolacustrine environments. However, several abstracts by McKelvey (1983) and McKelvey and Walker (1983) suggested that deposition occurred in fjordal or glaciolacustrine settings. Because of the variable thickness of the glacial units (0 to 350 m), Collinson et al. (1986) suggested that the glacigenic strata were deposited within valleys. They also interpreted breccias and diamictites exposed in the Morozumi Range and at Neall Massif (up to 56 m thick), as debrites derived from valley walls (Collinson et al., 1986). However, Collinson (personal communications, 2003) also suggested the possibility that these strata may have been deposited by glacial processes.

Emerging views of late Paleozoic glacigenic strata in the Transantarctic Mountains are in marked contrast to earlier reports that identified these units as the deposits of a terrestrial ice sheet that extended outward from Victoria Land across Antarctica to South Africa and South America in one direction, and across Australia in the other direction (Lindsay, 1970; Veevers and Powell, 1987; Barrett, 1991; Zeegler et al., 1997). In some areas, paleosols overlain by postglacial strata suggests that ice-free areas occurred locally along basin margins (cf., Collinson et al., 1986; Isbell et al., 2003, 2008) . A correlation of fossil spores and pollen with Australian palynomorph zones suggests that the Antarctic glacigenic strata are restricted to the Lower Permian. These findings suggest that glaciation was less widespread (temporally and spatially) than previously hypothesized. It is thus unlikely that a single, massive ice sheet covered Antarctica at any time during the Carboniferous and Permian. Ice flow directions into CTM and SVL suggest convergent ice flow from both the direction of present East and West Antarctica into the glaciomarine basins.

Post glacial basinal shales abruptly overlie glacigenic strata in CTM (Mackellar Fm. Discovery Ridge Fm.). Lonestones, interpreted as ice-rafted debris, only occur in the lower few meters of these strata. Basal post glacial shales grade upward into alternating lamina and thin beds of sandstone and mudrock, which in turn grade upward into thick beds of sandstone with channels in their upper reaches. These units are interpreted as turbdite/prodelta,, delta front, and distributary channel deposits (Collinson et al., 1994). Thick fluvial sandstones, siltstones, mudrocks,and coal gradationally overlie these units.

Middle and Upper Permian coal measure strata of the Mt. Glossopteris, Fairchild, and Buckley Formation overlie post-glacial strata in CTM. However, the Misthound Coal Meausres in the Darwin Mountains, the Weller Coal Measures in SVL, and the Takrouna Formation in NVL rest directly on the glacigenic strata (Isbell and Cuneo, 1997 and Collinson et al., 1986). Permian strata are both conformably and unconformably overlain by thick Triassic strata only in the Beardmore and Shackleton Glacier regions of CTM (Fremouw and Falla Fm.), and in SVL (Feather Conglomerate and Lashly Fm).

In NVL, a thick weathered horizon separates strata of the post-glacial Takrouna Formation from basement rocks. Although this pre-Takrouna horizon may be important in determining the glacial and climatic history of the region, it has received little attention. Coal-bearing strata of the 300-m-thick Takrouna Formation conformably overlie the glacigenic rocks. However, at several sites, Takrouna strata rest directly on a thick weathered horizon (up to 20 m thick) that separates basement rocks below from breccia and coal-bearing strata above (Dow and Neall, 1974; McKelvey, 1983; McKelvey and Walker, 1983; Collinson and Kemp, 1983; Collinson et al., 1986). The top of the Takrouna Formation is not exposed. The occurrence of thick, multi-storied, sandstone bodies suggest that deposition occurred in an extensive braided stream system (Collinson and Kemp, 1983; Collinson et al., 1986).

Changes in sedimentation patterns across the Permian-Triassic (P-T) boundary in South Africa, Spain, Australia, and Antarctica have been attributed to an increase in sediment yield following a massive die-off of land plants during the extinction crisis (Retallack and Krull, 1999; Ward et al., 2000; Michaelsen,

2002). For these areas, extinction is invoked as the driving mechanism that induced a change from Upper Permian flood-plain dominated successions to coarse-grained channel-dominated succession in the Lower Triassic. Although much attention has been given to the boundary in Antarctica (Retallack et al., 1998; Basu et al., 2003), the fluvial sedimentology and stratigraphy of these strata remain enigmatic. In CTM, and an abrupt change in composition from volcaniclastic to quartzo-feldspathic sandstones occurs across the boundary, and channel stacking patterns and fluvial styles vary across the basin and are different from the patterns predicted by the plant extinction hypothesis. Within strata of the Buckley and Fremouw formations, regional changes in fluvial stratigraphy indicate that sedimentation occurred within at least three different large-scale depositional sequences in an under-filled foreland basin. Upward within each sequence, a clastic wedge (high density stacking pattern) expands transversely into the basin. Expansion of the wedge is accompanied by a cratonward displacement of the deposits of a longitudinal basin axis (low density stacking pattern) and a transverse cratonic-margin (high density stacking pattern) drainage systems. Sequence boundaries are marked by unconformities, abrupt shifts in the deposits of the various drainage systems back toward the orogenic belt, abrupt changes in fluvial style and channel stacking patterns, and by abrupt changes in sandstone composition. Because the contact between the Buckley and Fremouw formations marks one of these boundaries, abrupt changes in fluvial style and sandstone stacking patterns occur within vertical successions. However, various combinations of channel densities are juxtaposed at different localities within the basin. The occurrence of sequences in the Beardmore Glacier region suggests that tectonism was a major control on the development of fluvial stratigraphy within these strata and that it controlled observed changes between the Buckley and Fremouw formation.

Permian and Triassic sedimentation in CTM, SVL, and NVL are complex. However, these strata provide an unparalleled view of changing climatic and tectonic conditions in the South Polar region of Gondwana during the late Paleozoic and early Mesozoic.

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CENOZOIC ALKALINE MAGMATISM AND VOLCANISM IN NORTH VICTORIA LAND, ANTARCTICA: A REVIEW

Philip R. Kyle
Department of Earth and Environmental Science, New Mexico Institute of Mining and Technology, Socorro NM 87801 USA
kyle@nmt.edu

ABSTRACT

Cenozoic magmatism is an important part of the geologic record in the western Ross Sea area. The numerous occurrences of volcanic and plutonic rocks are primarily related to extension associated with the West Antarctic Rift System. The alkali rocks are stratigraphic important because they represent the first terrestrial geologic record in the Transantarctic Mountains since the eruption of the Jurassic Ferrar Group. These alkali rocks can provide a window to understanding tectonic processes and as they are easily dateable can provide time planes for constraining important geologic events and processes.

The Cenozoic geologic record is subdivided into Paleogene intrusives (Meander Intrusive Group), which are likely to represent the remnants of eroded subvolcanic magma chambers, and Neogene volcanism belonging to the McMurdo Volcanic Group (MVG). The MVG is arbitrarily subdivided into the Hallett and Melbourne volcanic provinces in Northern Victoria Land and the Erebus volcanic province in South Victoria Land and includes numerous volcanic vents on the Ross Sea floor.

The Hallett volcanic province is 250 km long and is dominated by 4 large elongate piles of predominantly basaltic rocks. These were erupted from vents and fissures along the major crustal suture bounding the Transantarctic Mountains and the Ross Sea. Mantle up-welling and associated partial melting formed basaltic magma then leaked up the bounding faults and formed the linear piles. The volcanic rocks have been interpreted as being erupted under subglacial conditions but numerous studies have shown the presence of hydrovolcanic eruptions but there is no evidence the area was overlain by a thick ice sheet. Although basaltic rocks predominate there are a suite of differentiates including phonolites and trachytes.

The Melbourne volcanic province extends northward in an arcuate band from Mt Melbourne across the Transantarctic Mountains. It is the most extensive suite of volcanic rocks that were erupted through and onto the Transantarctic Mountains. Many of the volcanic fields in the province are poorly known. Three volcanic centers, The Pleiades, Mt Rittmann and Mt Melbourne are still considered to be active. This represents the most concentrated area of active volcanism in Antarctica. In Antarctica "active" is used to designate volcanoes that show evidence of recent eruptions based on radiometric ages, tephra records (in sediment and ice cores) or occurrences of geothermal features (i.e. steaming ground and ice towers). Mt Rittmann has steaming ground and is very poorly known. The Pleiades has pumice littering the surface in several areas and one peralkaline trachyte vent Taygete Cone is dated at 6±6 ka. There is a need to better establish an age for this vent and it is well suited for cosmogenic exposure age dating. Mt Melbourne has many thermal features on it summit and there is a major tephra exposed on the flanks of the volcano that has not been examined in any detail. It is inferred to be about 250 years old. The Talos Dome ice core contains numerous tephra ranging back to 16ka. It has been

suggested that most of the tephra originated from Mt Melbourne. Clearly Melbourne has had an extensive eruptive history and it does pose a hazard to the area. An effort should be made to develop a volcanic hazard map for Mt Melbourne.

KOREA ANTARCTIC GEOLOGICAL EXPEDITION: A SUMMARY OF THE FIRST TWO YEARS

Jusun WOO

Jusun WOO[1],Tae-Yoon S. PARK[1], Changhwan OH[1],Young-Hwan S. Kim, Ji-Hoon Kihm, Yoonsub Kim, Young-Min Kim, Taehwan Kim, Jong Ik LEE[1], Sang Bum Park, Insung Yoo, and Moon-Young CHOE[1]*

[1]Division of Polar Earth-System Sciences, Korea Polar Research Institute, Korea
[1]D, Chungbuk National University, Korea Polar Research Institute, Korea
[1]School of Earth and Environmental Sciences, Seoul National University, Korea

jusunwoo@kopri.re.kr

ABSTRACT

Korea's new Antarctic station, Jang Bogo Station opened in Februry 2014. It inaugurated a new era in the Korean Antarctic research. In 2011-12 and 2012-13 summer seasons, a group Korean geologists had started a pioneering research on northern Victoria Land (nVL) where the station would sit on. Then the Korea Antarctic Geological Expedition (KAGEX) officially started in the summer season of 2013-14 and carried out the first two expeditions. The research targets are the Lower Paleozoic Wilson Terrane metamorphism, Bowers Terrane stratigraphy, paleoenvironments of the late Paleozoic-Mesozoic Beacon Supergroup, and mineralization in nVL. Field works for stratigraphic revision of the Mariner Group (Bowers Super Group) has been done based on the three-year remote camp at the Eureka Spurs, the type section of the Mariner Group in the southern part of nVL. New setailed stratigraphic measurements and trilobite biostratigraphic informations suggest that the type section likely to have experienced significant structural repetition. Detailed measurement of the deep sea channel-fill deposit recognized a unique succession of breccia and diamictite which may expand our understanding of the deep sea channel processes and mass flow sedimentation. Combined with the detailed measurements of the section, detrital zircon ages of the sandstone units of the Bowers Supergroup were analysed. The preliminary result suggests that there was a tectonically calm stage during the deposition of the Mariner Group, than the Sledgers and Leap Year groups. Newly recognized clasts of dendrolite, a type of organo-sedimentary carbonates, in the breccia may shed light on the reconstruction of shallow paleoenvironments. The metamorphic rocks in the Wilson Terrane were investigated for revealing their provenance and metamorphic processes. Mesozoic wood fossils were collected in the Timber Peak and Schafer Peak formations (Beacon Supergroup) and Kirkpatrick Basalt (Ferra Group). Taxonomic and taphonomic analyses are being investigated. Rock and mineral samples of the nVL and the vicinity of the Jang Bogo Station are collected and analysed in terms of and major elements, REE, sulfur isotopes. Granite Harbour Intrusives and associated veins, mafic body of Glasgow Volcanics, and ultramafic complex at the terrane boundary were main targets of the samples are investigated in order to understand mineralization processes.

METAMORPHIC AGE AND PROVENANCE OF METASEDIMENTARY ROCKS IN THE WILSON TERRANE, NORTHERN VICTORIA LAND, ANTARCTICA

Yoonsup Kim

Department of Earth and Environmental Sciences, Chungbuk National University, Cheongju 362-763, Republic of Korea

ABSTRACT

The Wilson terrane, together with the Bowers and Robertson Bay terranes to the northeast, is located at the Pacific end of the Transantarctic Mountains, Antarctica. This terrane is primarily composed of Precambrian–Early Paleozoic medium- to high-grade NW-striking quartzo-feldspathic schists, gneisses, and migmatites as well as Cambro-Ordovician intrusive rocks. The U–Pb isotopic compositions of zircon from four metasedimentary rocks along a NE-to-SW traverse from Mt. Murchison to the O'Kane Glacier in the Wilson terrane were measured using a SHRIMP-II ion microprobe as a preliminary constraint on their provenance. Banded-gneiss samples WT001A and WT008 consisting of biotite, K-feldspar, plagioclase and quartz with or without pyroxene were collected from Mt. Murchison at the northeastern margin of traverse and near the Capsize Glacier in the Deep Freeze Range, respectively. Sample WT009 was collected from quartzite layers alternating with biotite schists near Mt. Levick in the Deep Freeze Range. Another banded-gneiss sample WT011 cropped out near Nash Ridge to the southwestern end of traverse. All the four samples similarly yielded 50–200 m long subhedral-to-anhedral zircon crystals showing variable internal zonation. In spite of small number of analyses, a significant contrast in the U–Pb age distribution patterns of detrital zircon has been observed.

Eighty-five spots were analyzed from eighty-one detrital zircon crystals of sample WT009, and their U–Pb age distribution is characterized by major populations at ~600 Ma, ~1.1 Ga, and 2.2–2.5 Ga with a prominent absence of middle Neoproterozoic (700–900 Ma) and middle-to-late Mesoproterozoic (1.2–1.7 Ga) zircon. The median age of youngest group is 587 Ma, probably representing the maximum depositional age of the quartzite layers. The U–Pb age distribution pattern of zircon is similar to that of banded-gneiss samples WT001A and WT008 except for conspicuous early Cambrian populations in the former gneiss. The weighted mean $^{206}Pb/^{238}U$ age of the early Cambrian fraction of zircon is 534 ± 11 Ma (t). This can be interpreted either as the timing of metamorphism in the banded gneiss or as an input of young syn-orogenic sediments progressively towards the northeastern margin of Wilson terrane. On the other hand, twenty-six spots were analyzed from sixteen zircon crystals of WT011, and their U–Pb age distribution is characterized by strong major populations at ~1.2 Ga, and minor populations at 1.5–1.7 Ga, except for one population at ~2.5 Ga.

The U–Pb compositions of zircon from a granitic dyke (sample WT001B) intruding the banded gneiss, sample WT001A of this study, and a boudinized granite (Sample WT013B) in schists near the O'Kane Glacier were also measured as a constraint on the minimum depositional ages of host-metasedimentary rocks. Zircon crystals in the former sample are euhedral and up to 400 m in length, mostly with concentric zonation and apparently inherited cores. The weighted mean $^{206}Pb/^{238}U$ age of outer rims is

483 ± 5 Ma (t), probably representing the timing of late- to post-orogenic magmatism. In contrast, zircon crystals in the latter sample are mostly subhedral and less than 100 m in length, with heterogeneous zonation. Their U–Pb ages are mostly discordant, owing to their high U and common Pb concentrations, and eleven best-concordant ages are older than 800 Ma. The weighted mean $^{206}Pb/^{238}U$ age of coexisting monazite in sample WT013 is 502 ± 23 Ma (t), probably representing the timing of peak metamorphism.

In summary, all the above preliminary geochronological data may reflect: (1) presence of heterogeneous stratigraphic units juxtaposed during the Ross orogeny; (2) a series of geological processes involving the late Neoproterozoic sedimentation, late Cambrian metamorphism, and late- to post-orogenic magmatism in the Wilson terrane; and (3) stratigraphic successions younging towards the northeast, metamorphosed possibly between 534 Ma and 483 Ma.

EET 14017: NEWLY RECOVERED LL3.0 CHONDRITE FROM VICTORIA LAND, ANTARCTICA

Changkun Park and Jong Ik Lee*

Korea Polar Research Institute, Incheon, Korea

changkun@kopri.re.kr

ABSTRACT

Chondrites are classified into type 1 to 6 that refer to aqueous alteration (type 1-2) and thermal metamorphism (type 4-6) of the originally primitive chondrites (type 3) on their parent bodies. Type 3 chondrites are subclassified into 3.0 to 3.9 by the metamorphic grade, the most primitive 3.0 to mildly metamorphosed 3.9. Type 3.0 chondrites are of great interest in chosmochemistry because they preserve chemical and isotopic records of the early Solar System. Here we report a newly recovered type 3.0 ordinary chondrite.

Elephant Moraine 14017 (EET14017) was recovered from Elephant Moraine, Victoria Land, Antarctica, 2014/15 season by Korea Expedition for Antarctic Meteorites. A polished thin section of EET14017 was studied using optical microscopy, X-ray mapping, and electron microprobe analysis.

EET14017 is classified as an LL chondrite based on large chondrules (0.9mm in average, up to 2mm) and low metal abundance (<1 vol %). Olivines and pyroxenes within chondrules show sharp extinction on cross-polarized light, indicating a low shock grade (S1). Moderate oxidiation of metal by terrestrial weathering is observed (W2). Mesostases of chondrules are mostly glassy with variable amounts of nucleates, indicating petrologic type 3. Relict forsterites are observed in some Fe-rich chondrules. Ferroan olivine grains in chondrules contain 0.44±0.18(1s.d.) wt% of Cr_2O_3 which characterizes EET14017 as one of the most primitive chondrite (type 3.0). Because Cr rapidly exsolves from olivine during heating (Grossman & Brearley, 2005), such amount of Cr in olivine indicates that EET14017 have avoided even weak thermal metamorphism on the parent body. Chromium is present in some Fe-Ni metal grains of magnesian chondrules, also supporting that EET14017 is the type 3.0 chondrite based on the fact that Cr is easily oxidized from metal grains even at low degree of thermal metamorphism (Zanda et al., 1994). An Al-rich chondrule consists of dendrites of olivine and Ti-bearing pyroxene and glassy mesostasis. Sodium in the mesostasis is concentrically zoned, with enrichments in the chondrule rim, possibly due to aqueous alteration on the parent body (Grossman et al., 2002).

EET14017 is the most primitive chondrite in the collection of the Korea Curation of Antarctic Meteorites. It is expected that the chondrite give us great chances to study primitive signatures of the early Solar System, including presolar grains in the matrix, extinct radionuclides (^{26}Al and ^{60}Fe) in chondrule minerals, relict olivines in Fe-rich chondrules, and aqueous alteration phases.

SESSION

Remote Sensing of the Changing Globe I (Marine)

THE NATIONAL SNOW AND ICE DATA CENTER

Mark C. Serreze

National Snow and Ice Data Center, Cooperative Institute for Research in Environmental Sciences, Campus Box 449 University of Colorado Boulder 80309-0449

serreze@nsidc.org

ABSTRACT

The National Snow and Ice Data Center (NSIDC) is dedicated to advancing our knowledge of the Earth's frozen realms. NSIDC is part of the Cooperative Institute for Research in Environmental Sciences (CIRES) at the University of Colorado Boulder. Our data management professionals and scientists work with data providers and users to create or publish data products, tools, and resources. We work to ensure that past, present, and future data remain accessible for studying the Earth and its climate. Scientists at NSIDC specialize in remote sensing of snow and ice, Arctic climate, frozen ground, ice sheets, glaciers, local and traditional knowledge and education and outreach. Informatics research at NSIDC focuses on an appropriately integrated system of systems with multiple points of external connection, grounded in well-curated data prioritizing scientifically useful descriptions and content that support community analyses as well as science education and outreach. NSIDC began in 1976 as an analog archive and information center, the World Data Center for Glaciology. Since then, NSIDC has evolved to manage cryosphere-related data ranging from the smallest text file to terabytes of remote sensing data from NASA's Earth Observing System satellites. NSIDC is a node the ICSU World Data System. My own areas of expertise, as Director of NSIDC, include atmosphere-ice-ocean interactions, Arctic hydro-climatology and boundary layer processes. Recent work includes research on the processes of Arctic amplification – the outsized rise in surface air temperatures over the Arctic compared to the rest of the globe, changes in tropospheric water vapor over the Arctic, and extreme precipitation events.

INTERDISCIPLINARY COORDINATED EXPERIMENT OF THE SOUTHERN OCEAN CARBON CYCLE (ICESOCC) – A FIELD CAMPAIGN SCOPING PROJECT

B, Greg Mitchell

Scripps Institution of Oceanography, University of California San Diego

gmitchell@ucsd.edu

ABSTRACT

Accurate estimates in time and space of organic carbon export to the ocean interior via plankton net community production (NCP) for the global oceans (the oceanic biological pump) is essential to understand the feedback between NCP, atmospheric CO_2 and climate. Since integrated, multi-sensor satellite observations of many ocean variables are required to estimate NCP from space, the problem is an interdisciplinary and complex challenge. Satellite ocean color sensors are a fundamental component in estimating spatial and temporal variations in NCP. Therefore, NASA's PACE mission (NASA-PACE 2012), a mission included in NASA's Climate Architecture Plan (NASA-CAP, 2010), specifies a need for field programs to improve satellite algorithms and models to reduce uncertainties in our estimates of NCP. The "*Interdisciplinary Coordinated Experiment of the Southern Ocean Carbon Cycle (ICESOCC)*" project is a NASA-funded field campaign scoping effort. The goal of ICESOCC is to integrate the input from scientific experts in ocean, atmosphere and ice physics and biogeochemistry, advanced observational tools, and models, to create a recommendation to NASA for field observations to help constrain our uncertainty of the Southern Ocean carbon cycle. The most successful result will be highly interdisciplinary, will require diverse observational methods, and will be international. Recommendations from the international scientific community are requested to ensure a robust recommendation to NASA.

EVALUATION OF ERRORS IN SATELLITE ESTIMATES OF PRIMARY PRODUCTION AND EXPORT PRODUCTION IN THE SOUTHERN OCEAN

Mati Kahru[1] *and B. Greg Mitchell*[1]

[1]*Scripps Institution of Oceanography, UCSD, USA*

mkahru@ucsd.edu

ABSTRACT

Many algorithms have been developed to estimate ocean primary production and export production from remotely sensed satellite data. The results of these algorithms are routinely used to evaluate climate trends and to calibrate global and regional earth system models. However, when the estimates of these satellite algorithms are compared to in situ measurements, the satellite estimates explain only a small portion of the total variance and the errors are large. We evaluate the magnitude of errors in satellite estimates of primary production and export production of the Southern Ocean caused by different factors and make recommendations for building optimized algorithms.

SATELLITE REMOTE SENSING ON WEST ANTARCTIC OCEAN RESEARCH (STAR)

Hyun-cheol Kim

Division of Polar Ocean Environment, KOPRI

kimhc@kopri.re.kr

ABSTRACT

Satellite remote sensing (RS) is used to understand the interaction among climate systems, such as cryosphere, marine biota. Polar environment provided an ideal experimental platform to prove feedback among the spheres because of the dramatic temporal variation of biota due to solar radiation change. Especially, the cryosphere is rapidly changing due to global warming. "Satellite remote sensing on west Antarctic ocean research (STAR)"project is launched since 2014 until 2016. On STAR project, west Antarctic Ocean is examined using RS with the numerical model of Antarctic Circumpolar Current (ACC) to understand the interaction between ACC and sea-ice. In addition, STAR project studies the relationship between sea-ice and ocean ecosystem (phytoplankton). STAR project includes the following research: 1) ACC frontal features and sea-ice dynamics research by RS and numerical model. 2) RS Ocean color-based primary production monitoring, 3) pCO2 and net community production monitoring and development of RS model for them, 4) RS algorithm assessment in high latitude region, 5) development of application of RS for multi-discipline research on Polar region.
Based on satellite remote sensing and numerical model, the connection between the sea-ice changes and climate systems are examined. Among the many components of the climate system, we seek for any possible relation between them.

UNRAVELING OPTICAL VARIABILITY OF DISSOLVED AND PARTICULATE MATTER IN THE NEW ZEALAND SECTOR OF THE SOUTHERN OCEAN DURING AN AUSTRAL SUMMER USING FIELD AND SATELLITE OBSERVATIONS

Eurico D'Sa[1] and Hyun-cheol Kim[2]*
[1]Louisiana State University, USA
[2]Korea Polar Research Institute, Incheon, Korea

ejdsa@lsu.edu

ABSTRACT

Optical properties of dissolved and particulate matter of surface waters in the New Zealand sector of the Southern Ocean were sampled along a transect that extended from New Zealand to Terra Nova Bay in the Ross Sea, Antarctica during the 2014 Austral summer. Satellite-derived estimates of temperature, salinity and phytoplankton chlorophyll obtained for the same period revealed the presence of various fronts and water masses that influenced the meridional variability of the particulate and dissolved organic matter optical properties along the transect. Absorption and fluorescence properties of colored dissolved organic matter (CDOM) were found to be most elevated in regions influenced by land masses off New Zealand and Terra Nova Bay and showed distinct variability at fronts separating water masses such as the warm Subtropical surface (STW) waters and the less salty and cooler Subantarctic surface waters (SAW). Analysis of CDOM excitation-emission fluorescence data using parallel factor analysis (PARAFAC) revealed the presence of two humic-like and two protein-like components, with a |dominant marine origin fluorescent component. Particulate absorption properties of phytoplankton and detrital material also showed distinct variability for the different water masses. The use of combined satellite and field optical observations in this study provided new insights into the surface distribution of dissolved and particulate organic matter pool along the New Zealand sector of Southern Ocean. This work is supported by the Korea Polar Research Institute.

FLOW AROUND GLACIER TONGUES

Craig Stevens[1,2]

[1]*NIWA National Institute for Water and Atmospheric Research, New Zealand*
[2]*University of Auckland, New Zealand*

craig.stevens@niwa.co.nz

ABSTRACT

Glacier tongues, the seaward extension of glacier outflows, form substantial obstacles along the coastal margins of Antarctica. For example, along the coastline of Victoria Land on the western margin of the Ross Sea there are at least ten substantial glacier tongues (Nordenskjöld, Harbord, Cheetham, Campbell, Drygalski, Tinker, Aviator, Icebreaker, Mariner, and Borchgrevink). With offshore extensions into the coastal ocean of ten km or more, and vertical thicknesses of 100-300 m, they likely significantly modify coastal surface currents as well as constrict flow between the coast and offshore islands.

Thus, there is interest in the connection between these glacial outflows and Antarctic regional coastal circulation. In this work, we use detailed observations of flow and stratification near the Erebus Glacier Tongue (hereinafter EGT), a small glacier tongue in southern McMurdo Sound, to quantify likely effects on stratification and coastal currents resulting from such obstacles. Newer data from the larger Drygalski Ice Tongue give hints about future directions for the work.

A VERTICAL GRADIENT OF NITROUS OXIDE BELOW THE SUBSURFACE OF THE CANADA BASIN AND ITS FORMATION MECHANISMS

Liyang Zhan

Liyang Zhan, Liqi Chen, Jiexia Zhang, Yuhong Li*

Key Laboratory of Global Change and Marine-Atmospheric Chemistry of the State Oceanographic Administration (SOA), Third Institute of Oceanography, SOA.

zhanliyang@tio.org.cn

ABSTRACT

The ocean is regarded as a significant source of N_2O, which is an ozone depleting greenhouse gas. However, the contribution of the Arctic Ocean to the global N_2O budget is not yet known. Herein, the first observations of N_2O concentrations in the Canada Basin (CB) and Greenland Sea Basin (GSB) are presented. A correlation between the historic atmospheric N_2O record and N_2O concentrations at the corresponding depth in the GSB suggests that the N_2O distribution pattern is dominated by air-sea exchanges and hydrographic processes in this region. The consistency between the observed N_2O concentrations in the CB and calculated results based on the above correlation suggest that the N_2O concentrations in the CB are most likely dominated by N_2O dynamics and subsequent hydrographic processes in the sea adjacent to the GSB. The N_2O concentration in the Canada Basin Intermediate Water (CBIW) reflects anthropogenic influences, whereas the N_2O concentration in the Canada Basin Deep Water (CBDW) suggests that the CBDW may be a preindustrial "relict".

SESSION

Remote Sensing of the Changing Globe II (Terrestrial)

ASSESSING THE TRAJECTORY OF SHALLOW ARCTIC WATER BODIES FROM SATELLITE OBSERVATIONS

Claude R. Duguay[1,2] and Kyung-Kuk (Kevin) Kang[1,2]

[1]Department of Geography & Environmental Management and Interdisciplinary Centre on Climate Change, University of Waterloo, Waterloo, Canada
[2]H2O Geomatics, Waterloo, Canada

crduguay@uwaterloo.ca / claude.duguay@h2ogeomatics.com
kev.kang@uwaterloo.ca / kev.kang@h2ogeomatics.com

ABSTRACT

Shallow water bodies (i.e. lakes and ponds ca. less than 4 m deep) are a ubiquitous feature of Arctic landscapes. There has been growing interest from the scientific community regarding the status of these shallow water bodies, as their growth or disappearance may be an indication of the effects of climate change. Climate warming has accelerated permafrost thaw in many regions of the circumpolar Arctic, leading to a drying of upland areas and an impounding of drainage in subsiding areas. Surface water in the landscape presents a positive feedback that enhances permafrost degradation in wet areas, which may either increase the availability of water to lakes and ponds or increase hydrologic connections between lakes and their surroundings, causing them to drain.

A few studies have used remote sensing to document trends and variability in lake surface areas over the past 50 years. However, there is an overall paucity of observations on the fate of the many shallow water bodies across the Arctic, and variability across regions is poorly known. Research is needed to determine whether expansion or drainage of these water bodies will dominate various types of permafrost landscapes over the coming decades, and which regions of the Arctic will be affected by these changes. In addition, there is a need to monitor changes not only in surface area/extent of water bodies but also that of other parameters indicative of their dynamics (e.g., fraction of bedfast ice, ice freeze-up/break-up dates and duration, surface water temperature, water turbidity, and water level). Long-term monitoring at multiple locations across the circumpolar Arctic is urgently needed to assess the trajectory and magnitude of changes in these parameters.

This paper will provide an overview of recent studies using remote sensing to investigate the dynamics of shallow water bodies in various regions of the Arctic. It will also propose a monitoring strategy in light of the recent and upcoming satellite missions. In particular, the Sentinel-1/2/3, RADARSAT Constellation and Surface Water and Ocean Topography (SWOT) missions will provide an unparalleled opportunity for furthering our understanding of the response of shallow Arctic water bodies to climate change.

IMPROVEMENT OF MODIS SNOW PRODUCTS FOR ARCTIC LAKE ICE

Kyung-Kuk (Kevin) Kang[1,2] and Claude R. Duguay[1,2]

[1]Department of Geography & Environmental Management and Interdisciplinary Centre on Climate Change, University of Waterloo, Waterloo, Canada
[2]H2O Geomatics, Waterloo, Canada

kev.kang@uwaterloo.ca / *kev.kang@h2ogeomatics.com*
crduguay@uwaterloo.ca / *claude.duguay@h2ogeomatics.com*

ABSTRACT

Lakes are sensitive indicators of climate variability and change. Observations of lake ice cover are important for studying the role of lakes in high-latitude weather and climate because the existence/absence of seasonal floating ice affects heat and energy transfers across the lake-atmosphere interface. Even though ground-based field observations provide a good temporal resolution, they provide a limited spatial representation, and few surface-based stations are located in high-latitude regions. In this respect, satellite remote sensing instruments are providing invaluable measurements for monitoring changes in timing of ice phenological events as well as for providing more spatially representative lake-relevant information than available from in situ measurements on large northern lakes.

The objective of this study was to evaluate and refine the existing NASA MODIS (Aqua and Terra) snow products for lake ice monitoring during freeze-up and break-up periods. MODIS data acquired over six large high-latitude lakes (Great Bear Lake, Great Slave Lake, Lake Winnipeg and Lake Manitoba in Canada; Lake Ladoga and Lake Onega in Russia) from 2003-2014 were used for analysis. MODIS/Aqua (Terra) 500 m snow products (i.e. MYD10_L2 and MOD10_L2, version 5) and refined products for lake ice were evaluated against optical imagery from MODIS/Aqua (Terra) Calibrated Radiances 5-Min L1B Swath 500m V005 (MYD02HKM and MOD02HKM). The main improvement of the new refined algorithm is that it can discriminate more clearly lake ice from thin clouds compared to the original MODIS snow algorithm. It also detects better ice cover of various stages of disintegration during the break-up period. Overall, the new algorithm presents a significant improvement for operational monitoring not only of ice cover on the large northern lakes analyzed in this study, but also on lakes of smaller size (~1 km^2 or larger) over the pan-Arctic domain on a regular basis.

COMPARISON OF DEM GENERATION METHODS AT THE TERRA NOVA BAY, ANTARCTICA AREA

Hong-Gyoo Sohn

Hong-Gyoo Sohn[1], Seunghwan Hong[1] and Hyoungsig Cho[1]*

[1]School of Civil and Environmental Engineering, Yonsei University, 50 Yonsei-ro, Seodaemun-gu, Seoul 120-749, Korea.

**Corresponding Author: sohn1@yonsei.ac.kr*

ABSTRACT

The demands of high resolution DEM in the Antarctica area for research and construction has been increasing. However, the construction of high resolution DEM in the Antarctica area is not easy due to the harsh weather condition and complex terrain. In this paper, we compared the terrestrial laser scanning, GNSS positioning and photogrammetry technique based on satellite images with respect to the accuracy and resolution of the generated DEM. The terrestrial LiDAR could be operated with high productivity and the generated DEM has high accuracy and precision. However, the weather and terrain condition had to be considered during scanning and registration process to ensure accuracy and precision. On the other hand, the GNSS positioning method was less vulnerable to the weather and terrain condition in the Antarctica area and could acquire the accurate 3D coordinates of observed points but it could not obtain continuous positioning information. Moreover, the DEM created from satellite stereo images could cover large areas but it had relatively lower resolution and accuracy than the ground surveying methods using terrestrial LiDAR or GNSS. In conclusion, when rough topographic information for research is demanded, the satellite-based methods can be suitable. However, when a few decimetres level of DEM is required for the applications such as facility construction or advanced topographic analysis, the terrestrial LiDAR can be the powerful solution for high resolution DEM generation.

SENSING THE BED-ROCK MOVEMENT DUE TO ICE UNLOADING FROM SPACE

Falk Amelung[1], Wenliang Zhao[1]

[1]College University of Miami, Florida, United States of America

famelung@rsmas.miami.edu

ABSTRACT

Ice-sheets in the Arctic region are retreating rapidly since late 1990s. Typical ice loss rates are 0.5 - 1 m/yr for the Canadian Arctic Archipelago, ~1 m/yr for the Icelandic ice sheets, and several meters per year for the edge of Greenland ice sheet. Changes in the ice load causes measurable deformation of the Earth's crust (several millimeter per year).

We use Interferometric Synthetic Aperture Radar (InSAR) observations to study bed-rock movements caused by deglaciation, using the the small baseline time-series analysis technique. We present several case studies of bedrock uplift observations in Iceland, Greenland and Tibet. The critical parameter to understand bedrock uplift is the distribution of Young's modulus within the Earth's lithosphere. If Young's modulus is known the bedrock the mass balance can be inferred from bedrock motion. If the mass balance is known the rheologic structure of the lithosphere can be constrained. The latter is required to better predict the Earth's crust response to waning glaciers.

THE U.S. NATIONAL ICE CENTER (NIC) USE OF REMOTE SENSING, MODEL, AND IN-SITU DATA FOR OPERATIONAL MONITORING OF GLOBAL SEA ICE

P. Clemente-Colón

U.S. National Ice Center, Washington, DC, USA

ABSTRACT

The U.S. National Ice Center (NIC) is a U.S. Government agency that brings together the Department of Defense - Navy, Department of Commerce – National Oceanic and Atmospheric Administration (NOAA), and the Department of Homeland Security – U.S. Coast Guard (USCG) to support coastal and marine sea ice operations and research in the Polar Regions. The NIC provides specialized strategic and tactical ice analyses to meet the operational needs of the U.S. government and is the only operational ice service in the world that routinely monitors sea ice in both the Arctic, Antarctic regions as well as in subpolar ice infested waters. In addition, the NIC provides daily global monitoring of land snow cover.

The NIC utilizes a variety of spaceborne imagery from active and passive microwave to Visible and infrared imagery with additional ancillary information from buoys and ships, airborne and field campaigns, and forecast models used to improve sea ice characterization and produce the analyses and forecasting. Key users of NIC products include the U.S. Navy submarine force, the NOAA National Weather Service, USCG and Canadian Coast Guard icebreakers, U.S. Military Sealift Command units used for re-supply missions to Thule Air Base in Greenland and McMurdo Station in Antarctica, and NOAA and National Science Foundation (NSF) research vessels.

Sea ice analysis charts (weekly, bi-weekly or twice a week depending on the region and season), daily marginal ice zone and ice edge routine products, as well as annotated imagery for tactical support are generated by expert analysts with wide access to near real time satellite imagery. Although not climate oriented, these products have captured a significant reduction of the Arctic sea ice extent cover, particularly in the last two decades, consistent with other independent observations and supporting the climate record. Furthermore, the percentage of the thicker and older multi-year ice in the winter has been shown to also continue to decrease precipitously. Instead, observations indicate a slight increase on sea ice extent in the Antarctic region, although the this increase is not evenly distributed around the continent with significant extent reduction in some areas including around the Antarctic Peninsula region while the Ross Sea region exhibits significant increase.

The use of present satellite, model, and in-situ data streams, planned use of upcoming sensors, and expected new capabilities for sea ice and snow monitoring in the near future will be discussed.

SESSION

Marine Geophysical Studies in the Polar Region

THE WEST ANTARCTIC RIFT SYSTEM IN THE AMUNDSEN SEA AND BELLINGSHAUSEN SEA SECTORS

Karsten Gohl

Karsten Gohl[1], Ricarda Dziadek[1] and Norbert Kaul[2]*

[1]Alfred Wegener Institute, Helmholtz-Centre for Polar and Marine Research, Bremerhaven, Germany
[2]University of Bremen, Department of Geosciences, Bremen, Germany

karsten.gohl@awi.de

ABSTRACT

The West Antarctic Rift System (WARS) is one of the largest continental rifts globally, but its lateral extent, distribution of local rifts, timing of rifting phases, and mantle processes are still largely enigmatic. It has been presumed that the rift and its crustal extensional processes have widely controlled the history and development of West Antarctic glaciation with an ice sheet of which most is presently based at sub-marine level and which is, therefore, likely to be highly sensitive to ocean warming. While the western domain of the WARS in the Ross Sea has been studied in some detail, only recently have various geophysical and geochemical/thermochronological analyses revealed indications for its eastern extent in the Amundsen Sea and Bellingshausen Sea sectors of the South Pacific realm and in the eastern Marie Byrd Land, Ellsworth Land, Thurston Island and Antarctic Peninsula crustal blocks. One of the current models, based on these studies and additional data, suggests that the WARS activity included tectonic translateral, transtensional and extensional processes from the Amundsen Sea Embayment to the Bellingshausen Sea region of the southern Antarctic Peninsula, basically following the eastward migrating collision of the Phoenix Plate with the Antarctic Plate. We present the range of existing and novel hypotheses regarding the extent of the eastern WARS as well as published and yet unpublished geophysical and geological data, including geothermal heatflow, that support a conceptual WARS model for West Antarctica with implications for glacial onset and developments.

THE HILLARY CANYON: A DOWNSLOPE ROUTE FOR ROSS SEA BOTTOM WATER

Laura De Santis

Laura De Santis[1], Lorenzo Petronio[1], Riccardo Geletti[1], Diego Cotterle[1], Nigel Wardell[1], Gualtiero Boehm[1], Ester Colizza[2] , Andrea Bergamasco[3], Jenny Black[4], Stuart Henrys[4]*

[1]Istituto Nazionale di Oceanografia e di Geofisica Sperimentale, OGS, Trieste, Italy
[2]Dipartimento di Matematica e Geoscienze, Università di Trieste, Italy
[3]CNR, ISMAR Venezia, Italy
[4]GNS Science, Wellington, NZ

ldesantis@ogs.trieste.it

ABSTRACT

The Hillary Canyon cuts the eastern Ross Sea continental slope and rise, to the Southeast of the Iselin Bank, and is directly connected to the Glomar Challenger Trough in the continental shelf. Cold dense salty water forms today in the Ross Sea polynya, spreads below the Ross Ice Shelf, becomes supercooled, fills up the landward deepening Glomar Challenger Trough and then spills over the sill of the shelf edge and flows downslope, often along the Hillary Canyon, in a geostrophic way, deviated westwards by the Coriolis Force, but sometimes also with a cascading a-geostrophic behaviour. This supercold water signal was found on the continental slope down to 1200 m depth. The shape of this tongue of modified ISW, whose thickness reaches up to 100 m, is very narrow, suggesting that the overflow occurs in very localized areas along the slope.

Here we combine seismic stratigraphy analysis of multichannel seismic reflection profiles in the Hillary Canyon and along the eastern flank of the Iselin Bank, with sea bed bathymetry and numerical modelling of the water masses vertical and spatial distribution, in order to identify modern and past pathway of the Ross Sea Bottom Water current.

Shear strength at the water-sea bed interface computed from modelling is compared with sediment grain size from a few box and gravity cores.

The results of this work show that the Hillary Canyon and the sediment mounds that formed along its flanks have been active since early Miocene times. Sediment drift-moat features and sediment waves are indicative of strong Norwest bottom currents reworking the sea bed sediments at different water depths along the slope, possibly since the late Miocene.

STUDY ON TECTONIC AVTIVITIES AND VOLCANISM NEAR ADARE TROUGH AND AUSTRALIAN-ANTARCTIC RIDGE

Jong Kuk Hong

Jong kuk Hong[1], Sung-Hyun Park[1], Young-Gyun Kim[1] and Seung-Goo Kang[1]*

[1]Korea Polar Research Institute, Incheon, Korea

jkhong@kopri.re.kr

ABSTRACT

West Antarctic Rift System (WARS) is the most noticeable tectonic feature in the Antarctica lying between East and West Antarctica, and the biggest continental rift system in the world. The region around Balleny Islands and Adare Trough is considered as the extension of the WARS from the Ross Sea. In 2014, KOPRI launched a new scientific program to study WARS mainly focusing on the Balley Islands and Adare Trough. In January 2015, KOPRI installed 5 hydroacoustic moorings around Balleny Islands and these will record acoustic signals for one year before recovery. Earthquakes, neo-tectonic activities, and ice noises are expected to be recorded by the hydrophones. In the Adare Trough, we made the marine heat flow measurements and collected sediment cores for paleomagnetic properties. Several volcanic rocks were also dredged to study their geochemistry. These data and samples are expected to provide a snapshot of the evolution of WARS. Australian-Antarctic Ridge (AAR) located at the extension of WARS has continued spreading after the cessation of the Adare Trough expansion and its mantle characteristics are expected to be correlated to those of around Balleny Islands and Adare Trough. The ridge has been surveyed three times in the early 2010s aboard Araon so that geophysical data such as swath bathymetry, gravity, and magnetic data were collected. Through the analysis of geophysical data and rock samples we will present bathymetric properties of the ridge, the formation processes of the oceanic crust and mantle, and their relations to the tectonic evolutions of the ridge and the Antarctic plate. We have also found clear evidences of topographic changes due to sea level changes by glacial-interglacial cycles.

SEISMICITY OF DAVID GLACIER, ANTARCTICA

Sridhar Anandakrishnan

S Anandakrishnan[1], L Zoet[2], R B Alley[1] and K Christianson[3]*

[1]Pennsylvania State University, State College, PA USA
[2]University of Wisconsin, Madison, WI, USA
[3] University of Washington, Seattle, WA, USA

sak@essc.psu.edu

ABSTRACT

Recording and analyzing natural-source seismicity in Antarctica can lead to insights on the the tectonic setting of the continent as well as the flow dynamics of glaciers. These two fields have been generally separate in their goals and techniques, but increasingly high-resolution measurements of local, regional, and global seismicity has allowed us to gain insights into glacier processes and oceanic processes in detail and dimension that was not possible before. With the advent of dense recording networks and high-sensitivity stations, allied to new processing techniques, we can monitor glacier flow behavior and high temporal resolution. We can monitor oceanographic processes such as sea ice formation and iceberg calving and ice shelf fracture at high temporal resolution.

In this talk I will survey results on the flow of ice streams in West Antarctica in which the motion of the glaciers can be measured by geodetic-quality GPS receivers. In addition, processes at the base of the glacier can be estimated by recording seismic emissions. Stick-slip behavior of Whillans Ice Stream and of David Glacier (in East Antarctica) are due to different but related phenomena - spatial changes in bed friction between the ice and the underlying rock or sediments. These two glaciers are at opposite ends of the glaciological flow spectrum (Whillans is broad and relatively flat, with ice boundaries, where David Glacier is narrow, steep, and has rock walls); nevertheless the presence of seismicity at the base can be used to determine flow properties and build more-accurate numerical models of the systems than would be possible without the measurements of those small earthquakes.

David Glacier has been proposed as a location where active erosion of a bedrock valley can be observed through seismic means. I survey the connection between glaciology and geomorphology in the context of this glacier, as well as in the context of similar phenomena in Greenland.

OVERVIEW OF 2013-2014 KOREA-CANADA-USA BEAUFORT SEA GEOSCIENCE RESEARCH PROGRAM

Young Keun Jin

Young Keun Jin[1], Jong Kuk Hong[1], Scott Dallimore[2], Charles Paull[3], Michael Riedel[2], and Humfrey Melling[4]*
[1]Korea Polar Research Institute Incheon Korea
[2]Geological Survey of Canada, Pacific, Sidney, B.C., Canada
[3]Monterey Bay Aquarium Research Institute, Moss Landing, Ca., USA
[4]Fisheries and Oceans Canada, Sidney, B.C., Canada

ykjin@kopri.re.kr

ABSTRACT

The Korea Polar Institute (KOPRI) is engaged in a long-term collaborative research program in the southern Beaufort Sea with the Geological Survey of Canada/Natural Resources Canada (GSC), the Monterey Bay Aquarium Research Institute (MBARI), Fisheries and Oceans Canada (DFO) with participation by Bremen University (BARUM). The ongoing focus is research activities on the KOPRI ice breaker IBRV Araon to investigate geological processes related to degrading permafrost, fluid flow and degassing, seismostratigraphy, and associated geohazards, of the Beaufort shelf and slope region. In addition, physical and chemical oceanography measurements of the Arctic Ocean were undertaken with linked atmospheric studies from the vessel. The expedition focused on two main research areas in the Canadian Beaufort Sea: the central shelf and slope areas offshore of the Tuktoyaktuk Peninsula and areas offshore of the Mackenzie Trough area.

Priorities for the Araon Expeditions, ARA04C (2013) and ARA05C (2014) in the southern Beaufort Sea included multi-channel seismic surveys and detailed bathymetric mapping to evaluate the interactions and linkages between oceanography and geologic processes in the outer shelf and slope area with the hope to collect sufficient site-survey data for the IODP proposal #806 and #753. The Araon also has several unique sediment coring instruments and underway water-property and atmospheric measurement devices. One of the highlights of these expeditions was the first documentation and collection of gas-hydrates from the mud volcano at 740 m water depth. Another important finding was the first documented presence of freshwater ice in the Cyan unit at 110 m water depth close to the shelf edge.

GEOCHEMICAL EVIDENCES ON THE METHANE CYCLING IN RELATION TO DISSOCIATION OF GAS HYDRATE IN THE SEDIMENT OF THE SLOPE REGION, THE BEAUFORT SEA

Donghun Lee

*Donghun Lee[1], Youngkeun Jin[2], Jongku Gal[1], Bohyung Choi[1] and Kyunghoon Shin[1]**

[1]Hanyang University, Ansan Korea
[2]Korea Polar Research Institute, Incheon Korea

shinkh@hanyang.ac.kr

ABSTRACT

Over the last fifteen years research efforts have been directed to survey the Beaufort Sea, in particular its shelf and slope, because terrestrial gas hydrates and permafrost underlying the shelf must be undergoing decomposition and thawing, as a result of the warming of the shelf initiated with the sea transgression of the last deglaciation. The ARA 05C expedition in the Canadian water of the Beaufort shelf and slope was conducted from the Korea Polar Research Institute (KOPRI) icebreaker ARAON on the during August 2014. In order to investigate the link between methane cycle in gas hydrate deposits and climate changes in the past, we studied the distribution of methane-related archaea and their pathway for understanding of the geochemical methane cycles in gas hydrate bearing sediments (ARA05C - 18GC). Archaeal lipid biomarker (*sn*-2-hydroxyarchaeol) tend to become relatively predominant showing depleted-$\delta^{13}C$ values of ca. –92‰, near Sulfate Methane Transition Zone (SMTZ). It could be the evidence of present methanotrophic activity in SMTZ through upward methane migrated from dissociated gas hydrate indicating lower chloride (Cl^-) concentration. Estimates between both gravity cores (ARA 05C - 10GC and - 18GC) collected from mud volcanoes on the Beaufort Sea were mapped to display the spatial variability in methane flux relative to different geological structures. Methane flux to the seafloor in gas hydrate bearing sediment (ARA 05C - 18GC) was relatively low, but increased in sediment (ARA 05C - 10GC) known as pingo-like-features suggesting that these features may provide conduits for upward methane flux to bypass the methanotrophic activities. Based on the archaeal lipid biomarker ratio (*sn*-2-hydroxyarchaeol/archaeol) as a tool to demonstrate the different ANME communities (ANME-1 and -2), a different distribution was found during the Late Pleistocene and Holocene. The abundances of archaeol and *sn*-2-hydroxyarchaeol significantly suggest that past temperature changes should result in higher methane emission, and also $\delta^{13}C$ values of archaeol represent a past record of fossil methanogenic archaea in gas hydrate bearing sediment core. Consequently, the geochemical signature of archaeal lipid biomarkers in the gas hydrate bearing sediment of the Beaufort Sea likely could be plausible evidence for the past and present changes of methane cycling in the Beaufort Sea, western Arctic.

POSTER SESSION

Lower and Upper Atmospheric Research in the Polar Region

ISOTOPIC VARIATIONS OF SNOW BY ALBEDO

Jeonghoon Lee[1], Yeongcheol Han[2], Ji-Young Ham[1], Un-Sung Na[2]*

[1]Dept. of Science Education, Ewha Womans University, Seoul 120-750, Korea
[2]Division of Climate Change, Korea Polar Research Institute (KOPRI), Incheon 406-840, Korea

[*]Corresponding author E-mail : jeonghoon.d.lee@gmail.com

ABSTRACT

Snow's albedo can be decreased if there is any impurities on the snow surface other than snow itself. Due to the decrease of albedo of snow, melting rates of surface snow can be enhanced, which is very crucial in climate change and hydrogeology in many parts of the world. Anthropogenic black carbons caused by the incomplete combustion of fossil fuel affect on snow and tephra particles generated by geologic volcanic activities reduce snow albedo. In this study, we investigated isotopic compositions between snow covered by tephra particles and clean snow. Isotopic compositions of snow with tephra statistically shows more enriched than those of clean snow ($p<0.02$). This can be explained by the fact that snow becomes enriched in ^{18}O or D relative to meltwater as melting rates are increased. In addition, the slopes of the linear regression between oxygen and hydrogen for snow with tephra and clean snow are 6.7 and 8, respectively, and the latter is similar to that of the global meteoric water line of 8. Therefore, we can conclude that snow impurities control the isotopic compositions of snow, which is very crucial in the study of climate change and hydrogeology. To quantitatively explain these observations, melting experiments and numerical approaches are required.

Key words: snow's albedo, tephra, melting rates, isotopic composition of snow

INTERANNUAL AND SEASONAL VARIATIONS OF ATMOSPHERIC MSA AND NSS-SO42- AT ZHANGSHAN STATION, ANTARCTICA

Miming Zhang, Jinpei Yan, Liqi Chen, Jianjun Wan, Qi Lin

Key Laboratory of Global and Marine-Atmospheric Chemistry, Third Institute of Oceanography, State Oceanic Administration, Xiamen

jpyan@tio.org.cn

ABSTRACT

To characterize impacts of atmospheric dimethylsufide (DMS) oxidation products on atmospheric sulfur-containing species, a multiple year-round aerosol sampling for studying methane-sulfonic acid (MSA) and non-sea-slat sulfate (nss-SO42-) was conducted from February 2005 to October 2008 at Zhangshan station, a research base in East Antarctica. The averaged values of MSA, and nss-SO42- are 21.46 ng m-3 (range from 0.02 to 295.58 ng m-3) and 94.18 ng m-3 (range from < 0 to 577.61 ng m-3) respectively over the four years. The atmospheric sulfur species concentrations present a strong seasonal cycle with maxima in austral summer and minima in austral winter. Maximum concentrations of MSA generally occur at early February while maximum nss-SO42- in early January or early February. The polynays or open waters in sea ice zone, the vicinity of Zhangshan station would play a critical role in contributing sulfur species to the atmosphere. The biological activities and areas of polynays or the open waters would significantly affect the atmospheric sulfur species concentration. On the other hand, the averaged value of MSA/nss-SO42- ratio was 0.18 ± 0.14. No significant correlation between air temperature and MSA/nss-SO42- ratio was found. However, the variation tendency of the MSA/nss-SO42- ratio values from January to March is well corresponded with the area of the polynya or open waters, suggesting that sea ice melting scenario would impact the atmospheric biological sulphur over Antarctica.

INVESTIGATION OF STRUCTURE AND FUNCTION OF TERRESTRIAL ECOSYSTEMS AT JAMES ROSS ISLAND, ANTARCTICA

Kamil Láska

Miloš Barták[1], Kamil Láska[2], Filip Hrbáček[2], Barbora Chattová[3], Daniel Nývlt[1], Kateřina Olejníčková[4], Peter Váczi[1], Ondřej Zvěřina[5], Jan Kavan[6], Luděk Sehnal[7] and Alena Žákovská[1]*

[1]Department of Experimental Biology, Masaryk University, Brno, Czech Republic
[2]Department of Geography, Masaryk University, Brno, Czech Republic
[3]Department of Botany and Zoology, Masaryk University, Brno, Czech Republic
[4]Department of Biology, Medical Faculty, Masaryk University, Brno, Czech Republic
[5]Department of Chemistry, Masaryk University, Brno, Czech Republic
[6]Centre for Polar Ecology, University of South Bohemia, C. Budějovice, Czech Republic
[7]Research Centre for Toxic Compounds, Masaryk University, Brno, Czech Republic

laska@sci.muni.cz

ABSTRACT

Since 2007, long-term research of structure and function of Antarctic terestrial ecosystems has been carried out on northern part of James Ross Island (JRI). In this abstract, we present an overview of field activities taken by Antarctic expedition crew in the period January-February 2015. Main attention was devoted to these directions: Climatology, Glaciers and pemafrost, Hydrology and limnology, Terrestrial Biology, Environmental Science, Medical Science, and Technical and Material Science. Within long-term projects, emphasis was given to climate characteristics (Láska at al. 2011) and an experiment with manipulated warming of vegetation cover using open top chambers (OTCs, measurements since 2007) approach. In Jan-Feb 2015, vegetation cover as well as microclimate in 12 OTCs, located in three contrasting localities of JRI, were investigated. Similarly to Barták et Váczi (2014), photosynthesis of *Bryum* sp. was evaluated by effective quantum yiled of photosyntem II using field instalations of fluorometers. Since 2012, heavy metal contents, mercury in particular, have been analyses regularly in different JRI ecosystems (Zvěřina et al. 2014). In Jan-Feb 2015, 150 samples from lakes, ponds, streams, soils, sediments, and lichen thalli were collected as a part of a follow up study.

Measurements of permafrost depth along a 6-km-long profile (Mendel station – Johnson mesa – Brandy Bay) and on permanent research plots was done using a probe approach. The data were compared to those recorded in previous season. At two monitoring plots covering an area of 5.600 m^2, soil samples in vertical profile of some probes were taken for further analyses of grain structure and mass/volume soil characteristics. Using a field system composed of oxygen electrodes, thermocouples, PAR sensors, and data loggers, *in situ* long-term (1 month in 5 min step) monitoring of dissolved oxygen

concentration was carried out in 2 ponds. Samples of soil, mosses and microbiological mats, seepages, wet rock walls, cryoconites from more than 120 individual sampling sites located on deglaciated part of JRI were taken to estimate biodiversity of Antarctic terrestrial diatoms, algae, cyanobacteria, and soil nematodes. Special attention was devoted to follow-up studies of diatoms (e.g. Kopalová et al., 2013) and colonization of seal carcasses (Nývlt et al., 2015, submitted) – see Fig.1. The samples represented small pieces of skin, bony tissue, substrate affected by organic matter input from decaying seal bodies and unaffected control (mineral substrate in close neighbourhood of the carcases. Diatoms, cyanobacteria and algae were isolated from the samples and cultivated on a Z and WC agars. Colonization of seal carasses by lichens and mosses was studied as well with the main ephasis given to the species richness in a close neighbourhood of the carcasses as dependent on liquid water availability and stage of dissintegration of seal remnants. To continue previous studies (Kosina et al., 2013), microbiological samples were collected from different terrestrial ecosystems in order to isolate Antarctic *Pseudomonas* sp. The mail goal is to detect and identify new bacteriocins (antibacterial proteins) in Antarctic *Pseudomonas* sp.

Fig. 1 Sampling of mosses, lichens, algae, cyanobacteria and bacteria close to seal carcasses.

Acknowledgments
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TRAPPED GREENHOUSE GAS IN WINTER ACTIVE LAYER: CASE STUDY FOR ALASKAN SHALLOW SOIL CORES

Eunji Byun

Eunji Byun[1], Ji-Woong Yang[1], Yongwon Kim[2] and Jinho Ahn[1]*

[1]Seoul National University, Korea
[2]International Arctic Research Center, University of Alaska Fairbanks, U.S.A.

bej0728@gmail.com

ABSTRACT

Differing from the shallow active layer by up to 20–30 cm in depth, the deeper part of that seasonally frozen layer has not been fully investigated despite its potential role in greenhouse gas emissions and its general increasing trends throughout all permafrost regions recent years (Vaughan et al., 2013). While the layer is included in the seasonally thawed range, some active microbes there can decompose organic carbon anaerobically. After long winter periods, some greenhouse gases may still remain, trapped due to the impermeable frozen surface; these gases could be released upon thawing but the controversial from place to place (Song et al., 2012; Tagesson et al., 2012). The gases at the deeper depth can remain unless their transport pathway is made. Then, these trapped gases may persist if their layer is incorporated again into permafrost so the gas permeability condition fails to occur.

Downward freezing during early winter sometimes generates inverted temperature gradients, characterized by frozen surfaces and warmer subsurface or deeper soils. In particular, the deepest part of active layer near the top permafrost remains above zero longer than shallower parts during winter. It is difficult to say that there must be some anaerobic decomposition by cold-adapted or resistant microbes; however, the depth-specific conditions relating to temperature change and other soil properties can be investigated to examine the possibility of greenhouse gas formation underground. In this study, we found an unusually high concentration of methane from the two of five soil cores, 7.6 cm in diameter and 90 cm long, drilled with SIPRE soil auger from Alaskan permafrost regions. One of them came from a tundra site in a continuous permafrost area of Alaska; the other, from black spruce forest sites with a thick surface organic layer composed of peat and feather mosses underlying discontinuous permafrost regime. The methane concentration profile of the frozen tundra soil core agreed to a certain extent with previous results from Elberling et al. (2011). The other at the bottom of the thick organic layer is attributable to the relatively warm temperatures during the entire winter and the gas impermeability of the compressed peats. On the contrary, carbon dioxide did not show any distinctive peak compared to its average concentration level which is a lot higher than that of methane. From the greenhouse gas profiles in frozen active layers, the depth of peak concentration can be stressed out and associated with abnormal efflux patterns during seasonal thawing if there are comparable surface measurement studies.

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GRAVITY WAVES VARIABILITY DURING 2009 MAJOR STRATOSPHERIC SUDDEN WARMING REVEALED IN HIGH-RESOLUTION ECMWF ANALYSIS AND GROGRAT

Byeong-Gwon Song

Byeong-Gwon Song[1], Hye-Yeong Chun[1], Peter Preusse[2], and Manfred Ern[2]*

[1]Department of Atmospheric Sciences, Yonsei University, Seoul, Korea
[2]Institute of Energy and Climate Research (IEK-7: Stratosphere), Forschungszentrum Jülich, Jülich, Germany

songbg@yonsei.ac.kr

ABSTRACT

Temperature amplitude and gravity wave (GW) momentum flux (GWMF) are calculated using the high-resolution European Centre for Medium-Range Weather Forecasts (ECMWF) analysis in order to investigate the variability of GWs during the 2009 major sudden stratospheric warming (SSW). Global domain is divided into sub-volumes, and for each sub-volume the most dominant wave component is determined through the 3-D sinusoidal fitting. It is found that strong temperature amplitude and GWMF exist along the polar vortex's edge at z = 25 km before the SSW occurrence, particularly over the southern coast of Greenland, Canada, and Russia. During the onset of the SSW, temperature amplitude and GWMF are enhanced in China. After the central date of the SSW, the polar vortex splits into two parts and GWMF have maximum value in Canada and Mongolia with reduced magnitude. The GWMF at z = 25 km revealed that the globally averaged zonal GWMF is reduced after the onset of the SSW. Waves with long vertical wavelengths, presumably orographic gravity waves, decreased as decrease of the westerly background wind during the onset of the SSW. Forward ray tracing is performed using the Gravity Wave Regional or Global Ray Tracer (GROGRAT) from z = 12 km with launched waves that are determined from the high-resolution ECMWF analysis data. Before the SSW occurrence, GWs that reach to z = 25 km are arranged along vortex's edge, and enhanced GWMF appears over China just before the central date of SSW. After the central date, GWs converged to America and China but the overall GWMF is strongly reduced. Backward ray tracing from z = 35 km is also carried out to find the source of gravity waves during the SSW. It is found that the GWs generated by orography contribute to the enhancement of GWMF over Mongolia during the onset of the SSW, while other sources such as jet/frontal systems and convections cannot be ignored.

POSTER SESSION

Reconstruction of Past Climate Records and Environment Records

SHALLOW ICE-CORE DRILLING ON STYX GLACIER, NORTHERN VICTORIA LAND, ANTARCTICA IN THE 2014-2015 SUMMER SEASON

Yeongcheol Han

Yeongcheol Han[1], Seong Joon Jun[1], Morihiro Miyahara[2], Sang Bum Hong[1], Hun-Gyu Lee[3], Jinho Ahn[3], Ji Woong Chung[1] and Soon Do Hur[1]*

[1]Korea Polar Research Institute, Korea
[2]ANORI Inc., Japan
[3]Seoul National University, Korea

yhan@kopri.re.kr

ABSTRACT

Ice cores are drilled from polar glaciers because they are useful for studying past climate and environment that change through time. We here report on the progress of the first shallow ice-core drilling program of Korea Polar Research Institute since the establishment of the Antarctic Jang Bogo station, the second Antarctic research station of Korea. The drilling was performed on the Styx glacier about 85 km north of the Jang Bogo station in the 2014-2015 summer season, and a 210.5 m long ice core was taken in 300 runs, in 20 days. The bottom of the ice core was tentatively dated to be 1.36 ka based on the depth-density profile and on the temperature at 10 m depth. The drill was stuck at a depth of 104 m but was recovered by utilizing ethanol as an antifreezing solution. The tephra ash layers were observed at depths of 97.01, 99.18 and 165.37 m, whose ages were estimated to be 0.56, 0.57 and 1.04 ka, respectively.

FIRN AIR SAMPLING IN STYX GLACIER, ANTARCTICA

Hun-Gyu Lee

Hun-Gyu Lee[1], Jinho Ahn[1], Sang Bum Hong[2], Yeongcheol Han[2], Seong Joon Jun[2] and Soon Do Hur[2]*

[1]Seoul National University, Republic of Korea
[2]Korea Polar Research Institute, Republic of Korea

hunkyoo2@snu.ac.kr

ABSTRACT

Firn located in the upper part of glacier is unpacked, porous snow layer. Because firn air at a depth can mix with above and below through convection or diffusion, variations in atmospheric composition propagate into the firn. Thus, firn air mobility should be investigated in order to accurately reconstruct past atmospheric air composition.

We sampled firn air in Styx Glacier, Antarctica (73°51′95″ S, 163°41′217″ E, 1623m asl). When several drilling runs were finished, we lowered a bladder and inflated it to shut off the air inflow from other depth. Then, pump system connected to bladder extracted air until CO_2 concentration of gas is stabilized. After stabilization, we sampled firn air in glass flasks and Silcocan canistors with overpressure of 1 or 2 atm. 17 air samples were collected at 12 depths in addition to 5 modern ambient air samples. The close-off depth where all air bubbles are captured in the ice was ~65.1 m.

CO_2 concentration of sampled firn air was reanalyzed by gas chromatography at Seoul National University. The preliminary results showed that CO_2 concentration decreased gradually (~ 0.2 ppm/m) above lock-in depth whereas it decreased rapidly (~ 8.1 ppm/m) below lock-in depth. The distinct difference comes from existence of lock-in zone where air can't move freely due to negligible diffusivity. The CO_2 concentraion at the lock-in depth of ~52.2 m is 391.1 ppm, equivalent to the atmospheric level in December of 2012 at South Pole. The ice age estimated from Herron-Langway densification model is ~269 years. Thus, ice-gas age difference is ~267 years.

Futher study should include constructing accurate chronology and evaluating gravitational fractionation effect for in-depth interpretation of firn air records.

PRELIMINARY RESULTS OF METHANE CONCENTRATION AND TOTAL AIR CONTENT MEASUREMENTS FOR GV7 ICE CORE, ANTARCTICA

Ji-Woong Yang and Jinho Ahn

School of Earth and Environmental Sciences, Seoul National University, Seoul 151-747, South Korea

luckyno44@gmail.com

ABSTRACT

Methane is the second most important greenhouse gases whose atmospheric mixing ratio is directly affected by both natural sources and anthropogenic activities. With growing anthropogenic impact on climate, understanding methane variation for the last millennia is important for better prediction of upcoming climate evolution. Here we present preliminary results of methane concentration and total air from GV7 ice core, East Antarctica (70° 41'S, 158° 52'E, 1950 m elevation). The ice core samples were largely fractured at depth of > ~120m, resulting reduced total air content (~60%) than typical values from other ice cores. Our early measurement data show greater CH4 levels than existing records from Law Dome and WAIS Divide ice core, possibly due to contamination by permeated drilling fluid into ice fractures which was not able to be removed by trimming process. To quantify the bias caused by the contamination ("fluid effect"), we carried out a series of blank test by injecting standard air on the ice samples after extracted all (~99.99%) the entrapped air. The observed bias range from 0 to 25 ppb. After subtracting the bias from the analyzed ice core methane concentrations, the GV7 data agree well with the existing records from other ice cores. However, precise ice chronology and delta age is essential for better comparison and further study.

CLIMATIC AND ENVIRONMENTAL CHANGES DURING THE LAST GLACIAL-INTERGLACIAL TRANSITION IN THE ROSS SEA, ANTARCTICA

Ester Colizza

Karin Mezgec[1,2], Ester Colizza[3], Lucilla Capotondi[4], Federico Giglio[4], Boo-Keun Khim[5], Leonardo Langone[4], Valentina Prelz[3], and Jong Kuk Hong[6]*

[1]University of Siena, Italy
[2]National Antarctic Museum – Section of Trieste - Italy
[3]University of Trieste, Italy
[4]National Research Council (CNR)-ISMAR, Italy
[5]Pusan National University, Korea
[6]Korea Polar Research Institute, Korea

colizzae@units.it

ABSTRACT

Four sediment cores (ANTA99-cJ3, ANTA95-98C, KI13-C1 and KI13-C2) and two box cores (KI13-bc2 and KI13-bc4), collected in the different geological settings of the Joides Basin-Central Basin area (Ross Sea, Southern Ocean), were studied in the framework of the Italian Antarctic Project ROSSLOPE (Past and present sedimentary dynamic in the ROSS Sea: a multidisciplinary approach to study the continental SLOPE). In this work we consider only the time interval spanning from the Last Glacial Maximum (LGM) to the Present in order to investigate the palaeoclimatic and palaeoceanographic evolution of the western Ross Sea during the last deglaciation phase. Based on the abundance pattern of diatom and foraminiferal assemblages as well as different geochemical and sedimentological properties (organic carbon, grain size, biogenic silica and $CaCO_3$ content), we propose a climatic and environmental reconstruction of the last glacial/interglacial transition in this regions of the Southern Ocean.

CO_2 EVASION FROM THE GREENLAND ICE SHEET: A NEW CARBON-CLIMATE FEEDBACK

Jong-Sik Ryu[1] *and Andrew D. Jacobson*[2]

[1]*Division of Environmental and Material Sciences, Korea Basic Science Institute, Chungbuk 363-883, Korea*
[2]*Department of Earth and Planetary Sciences, Northwestern University, 1850 Campus Dr, Evanston, IL, 60208, USA*

ABSTRACT

Decay of the Greenland Ice Sheet (GIS) figures prominently in climate change predictions, but direct carbon cycle feedbacks are poorly constrained. Here, we show that melting of the GIS yields a previously unknown flux of CO_2 to the atmosphere, and we use a reactive-transport model to examine if, how, and to what extent this flux will change as the ice sheet decays in a warmer world. Water emerges from beneath the Isunnguata and Russell Glaciers in West Greenland with CO_2 partial pressures (pCO_2) 3 - 10X supersaturated with respect to atmospheric equilibrium. During downstream transport in the Akuliarusiarsuup Kuua River, mineral weathering sequesters 76% of the excess CO_2 as HCO_3^- – a carbon sink on human timescales – and the remaining 24% evades to the atmosphere. Scaled to all rivers draining the GIS, the evasion flux of 0.11±0.03 Tg C/yr compares to fluxes reported for other rivers draining Precambrian shield crystalline rocks and having similar dissolved carbonate systematics. This flux is insufficient to influence modern-day atmospheric CO_2 levels, and we find that higher meltwater discharge alone will cause only moderate future increases. However, more substantial increases could occur if meltwaters intersect basal ice known to have elevated pCO_2 values. Worst-case model scenarios yield evasion fluxes of 100±20 – 170±40 Tg C/yr by 2100. These atmospheric CO_2 inputs surpass those for Arctic Lakes and would increase by up to ~25% those predicted for permafrost thaw. Our findings suggest that positive feedbacks linking greenhouse gas emissions, Arctic climate change, and global warming may be stronger than previously realized.

POSTER SESSION

Marine Geophysical Studies in the Polar Region

GEOPHYSICS OF THE AUSTRALIAN-ANTARCTIC RIDGE

Seung-Sep Kim

Seung-Sep Kim[1], Jian Lin[2], Sung-hyun Park[3] and Hakkyum Choi[1,3]*

[1]Chungnam National University, Daejeon, Korea
[2]Woods Hole Oceanographic Inst, Woods Hole, MA, USA
[3] Korea Polar Research Institute, Incheon, Korea

seungsep@cnu.ac.kr

ABSTRACT

Between 2011 and 2013, the Korea Polar Research Institute (KOPRI) conducted three consecutive geologic surveys at the little explored eastern ends of the Australian-Antarctic Ridge (AAR) to characterize the tectonics, geochemistry, and hydrothermal activity of this intermediate spreading system. Using the Korean icebreaker R/V Araon, the multi-disciplinary research team collected bathymetry, gravity, magnetics, and rock and water column samples. In addition, Miniature Autonomous Plume Recorders (MAPRs) were deployed at wax-core rock sampling sites to detect the presence of active hydrothermal vents. Here we present a detailed analysis of a 300-km-long supersegment of the AAR to quantify the spatial variations in ridge morphology and robust axial and off-axis volcanisms. The ridge axis morphology alternates between rift valleys and axial highs within relatively short ridge segments. To obtain a geological proxy for regional variations in magma supply, we calculated residual mantle Bouguer gravity anomalies (RMBA), gravity-derived crustal thickness, and residual topography for seven sub-segments. The results of the analyses revealed that the southern flank of the AAR is associated with shallower seafloor, more negative RMBA, thicker crust, and/or less dense mantle than the conjugate northern flank. Furthermore, this north-south asymmetry becomes more prominent toward the KR1 supersegment of the AAR. The axial topography of the KR1 supersegment exhibits a sharp transition from axial highs at the western end to rift valleys at the eastern end, with regions of axial highs being associated with more magma supply as indicated by more negative RMBA. We also compare and contrast the characteristics of the AAR supersegment with that of other ridges of intermediate spreading rates, including the Juan de Fuca Ridge, Galápagos Spreading Center, and Southeast Indian Ridge west of the Australian-Antarctic Discordance, to investigate the influence of ridge-hotspot interaction on ridge magma supply and tectonics.

ANALYSIS OF SHIPBOARD THREE-COMPONENT MAGNETOMETER ONBOARD IBRV ARAON TO REDUCE THE EFFECT OF THE SHIP DURING 2015 ANTARCTIC EXPEDITION

Sang-Mook Lee

Seoul National University

smlee@snu.ac.kr

ABSTRACT

CLUES FOR LATE CENOZOIC ANTARCTIC ICE SHEET AND BOTTOM CURRENT DYNAMICS FROM A SEISMOSTRATIGRAPHIC STUDY IN THE CENTRAL BASIN (ROSS SEA SLOPE)

Sookwan Kim

Sookwan Kim[1,2], Laura De Santis[3], Jong Kuk Hong[1,2], Young Keun Jin[1], Riccardo Geletti[3], Nigel Wardell[3], Lorenzo Petronio[3], Ester Colizza[4], Robert McKay[5] and Sung-ho Kang[1,2]*

[1]Korea Polar Research Institute, Incheon, Korea
[2]University of Science and Technology, Daejeon, Korea
[3]Instituto Nazionale di Oceanografia e di Geofisica Sperimentale-OGS, Trieste, Italy
[4]University of Trieste, Trieste, Italy
[5]Victoria University of Wellington, Wellington, New Zealand

skwan@kopri.re.kr

ABSTRACT

The Ross Sea embayment is one of the main glacial drainage outlets of the Antarctic Ice Sheet (AIS). The AIS evolution and ocean current dynamics during the mid-late Cenozoic time could be extracted from sedimentary sequence of the outer Ross Sea continental margin, that have minimum hiatus compared to the inner shelf region. The aim of this study is to contribute to the understanding of AIS and ocean current dynamics by reconstructing the paleo-depositional environment evolution, based on the seismic stratigraphy from the outer shelf to lower slope of the Central Basin (west of the Iselin Bank), from mid Miocene to the present.

Multi-channel seismic (MCS) profiles were acquired in the Central Basin during the 2012-2013 and 2014-2015 Antarctic expeditions with RV/IB Araon. The new data were combined with the existing MCS lines that were previously collected by the Italian Antarctic research Program (PNRA) and other data that were available from the Antarctic Seismic Data Library System (SDLS), in order to extend major ANTOSTRAT seismic horizons from inner shelf to continental slope and rise. The seismic grid was used for seismic sequence mapping (1) to reconstruct paleo-bathymetry at RSU4 (mid-late Miocene) and RSU2 (late Pliocene-early Pleistocene) times and (2) to calculate sedimentation rates since RSU4 time.

The seismic profiles show well-stratified aggradational sedimentary sequence from the outer shelf to the lower slope between RSU4 and RSU2 horizons. Above RSU2 horizon, prograding wedges developed in the outer shelf and upper slope. Well-developed sediment drift features produced by paleo-bottom water currents are observed along the slope of the Central Basin. The paleo-bathymetry at RSU4 and RSU2 appears to be similar to the present-day topography. Sedimentation rate between RSU2 and

the present seafloor is 2-3 times higher than between RSU4 and RSU2. The preliminary results of this study document the advance of the AIS over the shelf edge of the Central Basin region after RSU2 time.

SURFACE ELEVATION CHANGES ON THE SUBGLACIAL LAKES UPSTREAM OF THE DAVID GLACIER, ANTARCTICA USING CRYOSAT-2 AND ICESAT SATELLITE ALTIMETRY: A PRELIMINARY RESULT

Byeonghoon Kim[1], Choon-Ki Lee[2], Ki-Weon Seo[1]*

[1]Seoul National University, Seoul Korea
[2]Korea Polar Research Institute, Incheon Korea

cklee92@kopri.re.kr

ABSTRACT

In an area on subglacial lake, surface elevations of ice sheet can vary depending on the volume change of active lake. In this study, the surface elevation changes on the subglaical lakes upstream of the David Glacier are estimated based on the level 2 products of Cyrosat-2 satellite radar altimetry during 2010-2014 and compared with the previous results from the ICESat measurements during 2003-2009. Cyrosat-2 performs surface elevation measurements with high spatial resolution, by the benefit of the orbit with long repeat period and the SIRAL (Synthetic Aperture Interferometric Radar Altimeter) technique on high surface slope region. However, the best way to estimate the temporal elevation change from Cryosat measurements is still unknown because of the irregularity of point clouds. Two approaches are tested to estimate the small elevation change rate over the rugged terrain. We first use a model function representing surface undulations and time-varying components, which is defined in a small rectangle area. The second method is similar to the traditional repeat track method using triangular interpolation. In spite of the improved spatial coverage and resolution of Crysat-2, more sophisticated algorithm is still necessary to obtain the elevation change rates from Cryosat-2 measurements on a rugged terrain as accurate as those from ICESat.

ANALYSIS OF SUB-ANTARCTIC LAKE STABILITY USING A COUPLED BASAL HYDROLOGY MODEL

C. F. Dow[1], M. Werder[2], S. Nowicki[1], R.T. Walker[1]*

[1] NASA Goddard Space Flight Center
[2] Geographical Sciences, University of Zurich, Switzerland

christine.f.dow@nasa.gov

ABSTRACT

The presence of water at the bed of the Antarctic ice sheets is known to be a first order control on ice dynamics. In many regions, distribution and flux of this water is complicated by multi-year storage in subglacial lake basins. With more lakes and pockets of stored water being identified every year from surface altimetry measurements and radio-echo sounding it is apparent that constraining the impact of this water is an important step for determining the drivers of Antarctic ice dynamics.

We use a 2-D subglacial hydrology model, GlaDS, to examine the stability of sub-Antarctic lakes and their role in subglacial hydrological development. Our model incorporates development of a coexisting distributed and efficient drainage system. We apply the model to a synthetic system designed to emulate Recovery Ice Stream and test the sensitivity of parameters that control lake growth and drainage cycles.

INSIGHTS FROM VISCOELASTIC MODELING OF ICE STREAMS AND ICE SHELVES

Ryan T. Walker[1,2] *and Christine F. Dow*[2]

[1]*University of Maryland, College Park, Maryland, USA*
[2]*NASA Goddard Space Flight Center, Greenbelt, Maryland, USA*

ABSTRACT

While ice-sheet modeling is generally concerned with viscous ice flow, also considering the elastic properties of ice can allow insight regarding important physical processes. Modulation of ice-stream velocity by ocean tides can reveal ice strength and the nature of sliding at the ice bed. Elastic flexure of ice shelves allows detection of the grounding zone, and flexure-induced pressure changes in this region may affect the subglacial hydrologic system and physical properties of till. Vertical flexure is also a key process in the formation and drainage of subglacial lakes, which strongly influence subglacial hydrology and may affect ice dynamics.

I will present viscoelastic models of horizontal ice-flow perturbations and vertical ice shelf/sheet flexure. All of these processes are likely at work at Drygalski Ice Tongue, David Glacier, and other areas near Jang Bogo Station.

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

Masaki Kanao

Masaki Kanao[1], Takahiko Murayama[2], Masa-Yuki Yamamoto[3], Yoshiaki Ishihara[4]*
Takeshi Matshushima[5] and Yoshihiro Kakinami[3]

[1]National Institute of Polar Research, Japan
[2]Japan Weather Association, Japan
[3] Kochi University of Technology, Japan
[4]Japan Aerospace Exploration Agency, Japan
[5] Kyushu University, Japan

kanao@nipr.acc.jp

ABSTRACT

Characteristic features of infrasound waves observed at Antarctica reveal physical interaction involving surface environments in the continent and Southern Ocean. A single infrasound sensor has been continuously recorded since 2008 at Syowa Station (SYO; 39E, 69S), the Lützow-Holm Bay (LHB), East Antarctica. The recording data clearly represent background oceanic signals (microbaroms) during whole seasons. In austral summer in 2013, several field stations are established along the coast of LHB. Two infrasound arrays with different diameter triangles are installed at both SYO (100 m spacing) and on continental ice sheet (1000 m spacing). Besides the arrays, isolated single stations are deployed at two outcrops. The new arrays clearly identified the predominant propagating directions in NWN and their frequency content variations of microbaroms from Southern Ocean. Microbaroms measurement is a useful tool for characterizing ocean wave climate, complementing other oceanographic and geophysical data in the Antarctic. Moreover, characteristic signals are demonstrated, such as regional earthquakes, the airburst shock waves generated from meteoroid injection at the Russian Republic on February 2013. Detail and continuous observations of infrasound waves in Antarctica is a new proxy for monitoring a environmental changes such as global warming affecting on polar regions. One objective of CTBTO is to estimate the detection and location capabilities of the network at regional and global distances, another is to enhance the understanding of wave propagation through the atmosphere. Then increasing the number of stations in Antarctica is very efficient to provide the precious data in high southern latitude.

FLOW VARIABILITY OF BINDSHADLER AND MACAYEAL ICE STREAMS, WEST ANTARCTICA

Christina Hulbe

Christina Hulbe, Ted Scambos[2] , Marin Klinger[2] , and Mark Fahnestock[3]*

[1]National School of Surveying, University of Otago, Dunedin, New Zealand
[2]National Snow and Ice Data Center, Boulder, CO, USA
[3] Geophysical Institute, University of Alaska, Fairbanks, AK, USA

christina.hulbe@otago.ac.nz

ABSTRACT

Ice streams on the Ross Sea side of the West Antarctic Ice Sheet are known to experience flow variability on hourly time scales (tide influence near the grounding line), on annual time scales (basal water system variability) and on multi-century time scales (stagnation and reactivation linked to internal thermomechanical feedbacks). We now report on observations that fill in the missing time scale, flow variability at the decade scale, on the Bindschadler and MacAyeal Ice Streams (formerly D and E, respectively). The anlaysis makes use of new and archived ice velocity from Landsat imagery. Both streams speed up and slow down at rates of a few meters per year, with patterns guided by local geographic features. Changes at the downstream end of MacAyeal Ice Stream began recently. The emerging picture is of an ice stream system that experiences internal variability on many time scales.

MARINE REMOTE SENSING IN POLAR REGIONS USING AUTONOMOUS UNDERWATER VEHCILES

Isak Bowden Floyd[1], Alexander L. Forrest[1,2], Vanessa Lucieer[3]*

[1]Australian Maritime College, University of Tasmania, Australia
[2] Tahoe Environmental Research Centre, University of California – Davis, USA
[3]Institute of Marine and Antarctic Studies, University of Tasmania, Australia

Isak.BowdenFloyd@utas.edu.au

ABSTRACT

The increased utility of remote sensing technology in polar science is a result of the availability and advancement of cost effective systems capable of reliable data collection. The introduction of Autonomous Underwater Vehicles (AUVs) as data collection platforms in polar regions represents one of the most significant innovations seen within this research community. Through international and institutional collaborations, these vehicles have been deployed in under-ice operations to study physical oceanography and biology. Both large scale and fine scale data can be collected from a variety of AUVs developed for different tasks. Unique scientific questions have been able to be addressed that have recently been impossible using ship-borne and ice surface measurements.

The Antarctic and Southern Ocean Gateway Research Project is a collaborative partnership agreement amongst a number of Australian research institutes investigating various aspects of the polar environment. A key goal of this project is to develop a 'state-of-the-art', long range polar hybrid AUV with intervention capabilities. This vehicle will be able to conduct a broad spectrum of measurements both in open and ice covered waters to depths beyond 3000 meters. The capabilities of the AUV will enable key questions to be addressed such as: (1) determining sea ice and glacial ice tongue thickness; (2) quantifying the timing of physical processes at the sea-ice interface; (3) relating tidal excursion at the grounding line of large ice masses; and, (4) acoustic multibeam data collection of both the seafloor and under ice surfaces, which will lead to an understanding in paleoclimatic ocean conditions. In this talk, we will present lessons learnt from past under-ice deployments and our plans to advance the role of AUVs in polar research for under ice surveying, oceanic measurements and seafloor intervention into the future.

FLOW INTERACTION OF THE DRYGALSKI ICE TONGUE

Cameron Edwards[1], Alexander Forrest[1,2], Leong Zhi[1]*

[1]Australian Maritime College, Tasmania, Australia
[2] Tahoe Environmental Research Centre, Nevada, United States of America

cameron.edwards@utas.edu.au

ABSTRACT

The Drygalski Ice Tongue (DIT) acts as a barrier to the prevailing Northward current present in McMurdo Sound of Antarctica's Ross Dependency and due to this impedance the DIT is believed to be a vital factor in the formation of the Terra Nova Bay polynya. Of particular interest is the influential extent of the DIT upon the fluid motion in upstream, downstream and underneath areas and the associated eddy structure, specifically the extent of streamwise elongation and eddy interaction. These results will allow for oceanographic and biological inferences into particle transport within the region. Collected Conductivity-Temperature-Depth profiles in the 2014 field campaign adjacent to the sidewalls of the DIT show either a well-mixed layer in the upper ninety meters, a continuously stratified flow down to seven hundred meters or a two-layer flow from ten to seven hundred meters. This study investigates the downstream flow condition of each of these flow regimes. To accurately evaluate these scenarios, Reynolds-averaged Navier Stokes (RANS)-based Computational Fluid Dynamics (CFD) simulations utilising the Shear Stress Transport turbulence model (SST) and Baseline Turbulence Model Reynolds Stress Model (BSLRSM) are used to predict the flow characteristics in the aforementioned areas and provide an accurate insight into the DIT's physical influence upon the surrounding area. This paper will serve to further increase the understanding of under-ice flow modelling and specifically the unquantified fluid transport around the DIT and Terra Nova Bay.

EXPULSION OF METHANE-RICH WARM FLUID FROM MUD VOLCANO IN THE CANADIAN BEAUFORT SEA, ARCTIC OCEAN

Young-Gyun Kim[1], Young Keun Jin[1], Jong Kuk Hong[1], Scott Dallimore[2], Charles Paull[3], Michael Riedel[2]*

[1]Korea Polar Research Institute, Incheon, Korea
[2]Geological Survey of Canada, Pacific, Sidney, B.C., Canada
[3]Monterey Bay Aquarium Research Institute, Moss Landing, Ca., USA

[*] *ygkim@kopri.re.kr*

ABSTRACT

Marine heat flow measured at subsurface interval of a few meters using a heat probe is one of useful approaches to show the status of fluid circulation within the marine sediments, even though it can show only a snapshot of long-term variation caused by the fluid circulation. Marine heat flow measurements using a 5 m-long Ewing-type heat probe was made at the Canadian Beaufort Sea margin during the 2013 and 2014 R/V Araon Arctic cruises as the Korea-Canada-U.S. cooperative research project. Observation results on the flat top of the mud volcano seem to support the evidence that warm methane-rich fluid has been emitted through sediments into the ocean. For instance, we found: 1) gas hydrates embedded in the sediment as crystal form, 2) a much higher geothermal gradient than that from the outside of the mud volcano as well as the background value from the regular seafloor, 3) a much higher seafloor temperature compared with bottom water temperature, 4) a significantly high methane concentration from the water samples, 5) gas plumes through the water column emitted from the top of mud volcano. Comparison with background thermal conductivity, geothermal gradient, and physical properties from the reference site implies that substantially high heat flow of the mud volcano stems mainly from high thermal gradient. We need a further study on configuration of such warm fluid generating the high geothermal gradient to assess the gas hydrate stability zone across the mud volcano.

MULTI-CHANNEL SEISMIC SURVEY IN THE OUTER CONTINENTAL SHELF OF THE BEAUFORT SEA

Seung-Goo Kang

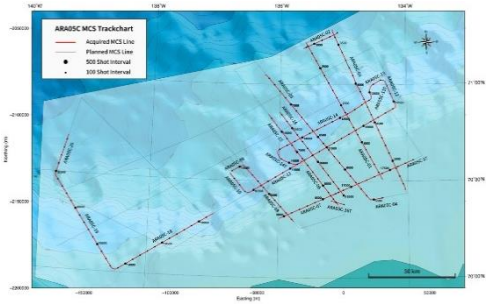
Seung-Goo Kang[1], Jong kuk Hong[1], Sookwan Kim[1], Yong Keun Jin[1],*

[1]Korea Polar Research Institute, Incheon, Korea

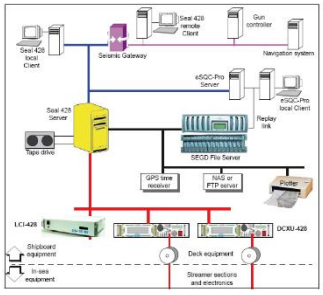
ksg9322@kopri.re.kr

ABSTRACT

The multi-channel seismic exploration was conducted in the outer continental shelf of the Beaufort Sea, Arctic from 2nd to 13th September 2014 using the R/V Araon. In order to investigate sub-botton structures, sedimentary stratigraphy, permafrost, gas hydrates in the critical boundary zone of the shallow shelf and slope region, we obtained seismic data on 23 lines and the total survey length is 998 km with 19,962 shots for 12 days. The shooting interval was set 50m, the group interval was 12.5m and 120 channels made 8 folds of coverage. The source and streamer depth set 6 m.



Track chart of the seismic survey of ARA05C



Schematic diagram of the MCS system

We conduct the seismic data processing to generate sub-surface images using GEDCO VISTA 10.0. Firstly, we performed basic setp of data processing such data loading, band-pass & F-K filtering, geometry correction, velocity analysis, NMO correction, CMP stacking. Due to survery area had shallow watger depth about 45m~55m, the direct wave and refrected waves overlapped with primary reflection events in stack images. Some seismic survey lines, however, shows good quality like deep geological structure and clear reflection events such as unconformity, mud volcano, faults.

Now, we conduct more detailed data processing such as detailed velocity analysis, demultiple-SRME, f-k filtering, Tau-p decon to get more accurated seismic images. In addition, we carry out the full waveform inversion to construct the high-resolution underground velocity structure of survey area. It will support IODP pre-proposal #806 forcused on geo-hazards associated with permafrost and gas hydrates.

PREDICTION OF POTENTIAL AVALANCHE RELEASE AREA FOR THE ANTARCTIC PENINSULA

Sung-Min Kim

*Sung-Min Kim[1], Huiuk Yi[1], Jihwan Park[1], Myeongchan Oh[1] and Hyeong-Dong Park[1]**

[1]Department of Energy Systems Engineering, Seoul National University, Seoul, Korea

hpark@snu.ac.kr

ABSTRACT

Since the Antarctic Peninsula has the mildest climate in Antarctica, research stations are concentrated on there, or on the many nearby islands. In addition, it is the part of Antarctica most often visited by tourists. Although there are not many people in the region, avalanches can be a threat to researchers or tourists because the peninsula is highly mountainous. However, there are few studies and data on the avalanches of Antarctica. The goal of this study is to determine the potential release areas of avalanches, which is the first step in the avalanche hazard mapping. The most useful sources of information are historical avalanche events but, for areas like Antarctica where no historical data are available, other methods considering topographical parameters should be applied. In this study, topographical parameters such as slope angle, curvature and aspect, and other factors derived from 100 m resolution Digital Elevation Model (DEM) were analyzed in a Geographical Information System (GIS). The result can be used to assess the avalanche hazard for paths and be a useful indicator of avalanche hazard in the Antarctic Peninsula.

MICROSTRUCTURES OF MAGNETIC CRYSTALS

Rae-Gyung Ha

Rae-Gyung Ha [1], Yongjae Yu[1], and Jongkuk Hong[2]*

[1]Chungnam National University, Daejeon, Korea
[2]Korea Polar Research Institute, Incheon Korea

yongjaeyu@cnu.ac.kr

ABSTRACT

Although domain observations and micromagnetic calculations are at last converging, there are very significant discrepancies between experimental relatity and predictions. Grains that remain in a metastable single-domain state should theoretically not exist above a critical size which for magnetite (Fe_3O_4) is about 1 mm, but metastable single-domain grains certainly exist well into the micron range in Ti-bearing titanomagnetite. Accoring to our calculation, highly acicular magnetite prefers double vortex configuration. In particular, each vortex showed the opposite spin arrays, resulting in a low remanent magnetization. For magnetite, it is apparent that non-uniform magnetization without recognizable domains nucleate at surface or interior defects in imperfect crystals.

CORE FREEZING RECORDED BY PRECAMBRIAN GEOMAGNETIC FIELD

Doohee Jeong

Doohee Jeong [1], Yongjae Yu[1], and Jongkuk Hong[2]*

[1]Chungnam National University, Daejeon, Korea
[2]Korea Polar Research Institute, Incheon Korea

yongjaeyu@cnu.ac.kr

ABSTRACT

The strength of the Earth's magnetic field through geological time is a principal constraint on the Earth's core dynamo. Our broad trends, such as the Mesozoic dipole low, can be discerned at present. To test the expected latitude dependence of a dipole field, results from sufficiently different paleolatitudes are required. Compiled Precambrian paleointensity record from the literature forms clusters in specific time intervals as orogenesis was episodic. It is true that only several lithologic units or pairs of units are available. Yet it can be proposed that the Precambrian geromagnetic field was not markedly less dipolar than the present geomagnetic field. Perhaps nucleation of inner core initiated enhanced contribution of non-dipolar fraction, as the core freezes.

ON THE USE OF MAGNETIC PROPERTIES FOR UNDERSTANDING THE SPREADING OF OCEANIC RIDGES AT HIGH LATITUDES

Hanul Kim

Hanul Kim [1], Yongjae Yu[1], and Jongkuk Hong[2]*

[1]Chungnam National University, Daejeon, Korea
[2]Korea Polar Research Institute, Incheon Korea

yongjaeyu@cnu.ac.kr

ABSTRACT

A suite of magnetic testing was carried out including alternating-field and thermal demagnetization experiments, magnetic hysteresis observation, thermomagnetic analysis, scanning electron microscopy, and electron probe micro analysis. Two different magnetic phases were identified as fine-grained round Titanomagnetite ($Fe_{2.4}Ti_{0.6}O_4$) and coarse-grained elongated Magnetite (Fe_3O_4). Applying a suite of rock magnetic analysis on crustal rocks from high/intermediate latitudes is nearly unprecedented. The present study may provide valuable information on the evolution of lithosphere at high/intermediate latitudes since the Pangea break-up as young MORBs contain titanomagnetite crystals of varying size and composition.

TRACING THE GEOMAGNETIC SOUTH POLES IN ANTARCTICA

Hoabin Hong

Hoabin Hong [1], Yongjae Yu[1], and Jongkuk Hong[2]*

[1]Chungnam National University, Daejeon, Korea
[2]Korea Polar Research Institute, Incheon Korea

yongjaeyu@cnu.ac.kr

ABSTRACT

Using continuous spherical harmonic global geomagnetic field models, wandering path of geomagnetic south poles was drawn. For the past 4000 years, geomagnetic south poles remain relatively standstill, although several cusps were recognized. In particular, sense of anticlockwise migration of geomagnetic south poles was reversed about 500 years ago. At present, geomagnetic south poles trace clockwise motion. Mean position of geomagnetic south poles for the past 4000 years matches well with the geographic South Pole within uncertainties, providing rationale on the use of geocentric axial dipole as long as secular variation of geomagnetic field is averaged-out.

POSTER SESSION

Planetary Geology and Geological Evolution of the Victoria Land: Reviews and New Views

SEQUENCE STRATIGRAPHY: A NEW APPROACH TO THE DEVONIAN TAYLOR GROUP (BEACON SUPERGROUP) IN SOUTHERN VICTORIA LAND, ANTARCTICA

Margaret A Bradshaw

Department of Geological Sciences,
University of Canterbury, Private Bag 4800, Christchurch 8020, New Zealand

margaret.bradshaw@canterbury.ac.nz

ABSTRACT

The Taylor Group (Devonian) forms the lower half of the Beacon Supergroup and has a maximum thickness of 1200 m in southern Victoria Land. The sediments were deposited in the McMurdo sedimentary Basin that extended from the Fry Glacier (N) to the Shackleton Glacier (S) along the line of the Transantarctic Mountains and was developed over deeply eroded Ross Orogen rocks. Study of this group is hampered by a narrow and sometimes discontinuous outcrop, and fossil content is sparse. The succession has been divided into seven formations. The principles of sequence stratigraphy allow the recognition of at least five cycles, four with a basal erosion surface followed by coarse deposits. The basal unconformity (Kukri Erosion Surface) in the McMurdo Dry Valleys region has a rugged topography, and the succession shows a northward inundation of the basin. On New Mountain the base of the Taylor Group (Windy Gully Sandstone) progressively buries a 30 m high block-mantled ridge of Granite Harbour Intrusives. Windy Gully Sandstone grades up into the Terra Cotta Siltstone that thickens southwards (max. 80 m), the top of which is marked by deep, sand-filled desiccation cracks indicating sub-aerial exposure, marking the end of the first cycle. The succeeding New Mountain Sandstone (second cycle) is regionally more extensive than the Windy Gully Sandstone, is coarse and feldspathic at its base with layers of granules to small pebbles and rip-up clasts, and rests on basement in the north. The unit becomes more quartzose higher in the section, with densely bioturbated beds of the burrow *Heimdallia*. Slumping, dewatering structures and desiccated horizons appear towards the top of the formation. The Heimdall Erosion surface cuts across the New Mountain Sandstone and marks the start of the third cycle. This surface is remarkably flat but dies out southwards. Where present it is mantled by conglomerates and coarse sandstones at the base of the Altar Mountain Formation. Biscuit-like slabs of sandstone suggest lithification of the New Mountain Sandstone during a period of exposure before the Heimdall Erosion Surface was cut, consistent with a fall in sea level. The central part of the Altar Mountain Formation contains abundant *Skolithos* burrows, but these become fewer as the unit passes upwards into ripple-laminated siltstones and numerous thin desiccation-cracked green siltstones. The start of the fourth cycle is marked by a change to parallel-bedded sandstones of the Arena Sandstone that has a clay cement which may indicate original feldspar. The change is also marked by the abrupt appearance of *Beaconites* burrows indicating a change of conditions. A locally developed conglomerate at the base of the overlying Beacon Heights Orthoquartzite marks the beginning of the fifth cycle, although the conglomerate is not widely recorded. In the north the orthoquartzite rests directly on

basement. The orthoquartzite grades up into the Aztec Siltstone, which is truncated by the unconformity at the base of the Victoria Group. The Aztec Siltstone contains more mud than any of the underlying formations, and root horizons occur in sandstone and in overbank siltstones. Interbedded coarse sandstones contain bioclasts of disarticulated fossil fish. The fish fossils indicate that the formation youngs from north to south and is of middle to late Devonian age.

GEOCHEMICAL CONSTRAINTS ON MANTLE SOURCES FOR VOLCANIC ROCKS FROM MT. MELBOURNE AND THE WESTERN ROSS SEA, ANTARCTICA

Mi Jung Lee

Mi Jung Lee[1], Jong Ik Lee[1], Taehoon Kim[1]and Keisuke Nagao[1]
[1]Korea Polar Research Institute, Korea

mjlee@kopri.re.kr

ABSTRACT

We report geochemical and isotope data (Sr, Nd, Pb) of submarine samples from the Terror Rift Region and subaerial lavas from Mt. Melbourne Volcanic Field (MMVF) in the western Ross Sea. The MMVF samples can be subdivided into Groups A and B based on their temporal and spatial distribution. All samples are alkaline, ranging from basanite to trachybasalt, and exhibit an HIMU-like isotopic signature ($^{206}Pb/^{204}Pb$ = 18.510–19.683, $^{87}Sr/^{86}Sr$ = 0.70300–0.70398, $^{143}Nd/^{144}Nd$ = 0.51284–0.51297) and trace element affinities (Ce/Pb = 25–35, Nb/U = 45–60, Ba/Nb = 5–13, La/Nb = 0.5–0.9). The Terror Rift submarine lavas (0.46–0.57 Ma) display a distinct trend, with more primitive geochemical characteristics (higher MgO (7.2–9.8 wt.%) and CaO (9.9–11.9 wt%) and stronger HIMU signature than those of MMVF basalts. Results from a rare earth element (REE) model suggest that the Terror Rift submarine lavas are derived from small degrees (1–2%) of partial melting of an amphibole-bearing garnet peridotite mantle source. Incompatible trace element ratios (e.g., Ba/Nb = 6.4–13.2, La/YbN = 14.4–23.2, Dy/Yb = 2.2–3.0) and isotopic compositions of the MMVF Group A and B volcanics suggest derivation from higher degrees (2–5%) of partial melting of a garnet peridotite source and strong influence of an EMI-type mantle source. The stronger HIMU signature of the Terror Rift submarine lavas appears to be related to smaller degrees of partial melting, suggesting preferential sampling of the HIMU component in the less partially melted rocks from the Cenozoic NVL magmatism. In contrast, the higher degree of MMVF A and B magmas can be explained by greater interaction with heterogeneous lithospheric mantle, resulting in a diluted HIMU signature compared with that of the Terror Rift submarine lavas.

HALOGEN (CL, BR, I) GEOCHEMISTRY IN MID-OCEAN RIDGE BASALTS FROM THE AUSTRALIAN-ANTARCTIC RIDGE (AAR)

Yun Seok Yang

Yun Seok Yang[12], Jung Hun Seo[2], Sung Hyun Park[1], Taehoon Kim[1]

[1]Korea Polar Research Institute, Korea
[2]Inha university, Incheon, Korea

zinid@kopri.re.kr and seo@inha.ac.kr

ABSTRACT

Australian-Antarctic Ridge (AAR) is an extension of easternmost SE Indian Mid-Ocean Ridge (MOR). We collected basaltic glasses from the in-axis of the MOR (**in-axis**: KR1 axis and KR2 axis), the off-axis seamounts (**seamount**), and the overlapping zones of MOR and seamounts (**KR1 mixing**). Halogen concentrations and ratios in the basaltic glasses are important to understand a mantle metasomatism and its volatile recycling. (Kendrick et al., 2012) Previous qualitative analyses of halogen elements by SIMS indicate that the basaltic glasses from the AAR contain detectable halogens (F, Cl, Br, I). We synthesized the halogen-bearing glasses, and determined its halogen concentrations by Rutherford Backscattered Spectroscopy (RBS) and LA-ICP-MS. The synthesized basaltic glasses (SRM 5 and SRM test 7) were adopted as the external standard reference materials (SRM) for LA-ICP-MS microanalyses of the halogens in the natural AAR basaltic glasses.

The AAR basaltic glasses contain MgO of 1.7~8.3 wt%. The concentrations and ratios of K_2O, Cl, Br, I and Th/Sc in the glasses increase during decreasing MgO concentrations (magma fractionation), while the patterns in the K_2O and Th/Sc are different between the in-axis and the KR1 mixing. Halogen concentrations in the glasses of the KR1 mixing area are relatively higher compared to the in-axis and the seamount area. The Br/Cl ($\times 10^{-3}$) ratios tend to decrease in the in-axis and increase in the KR1 mixing during decreasing MgO concentration. The Cl/Br and Th/Sc ratios in the in-axis region and in the KR1 mixing region show positive and negative correlations, respectively. While the halogens contents in the AAR glasses change in all regions, the Cl contents are the least variable compare to the other halogens such as Br and I. The glasses in the KR1 mixing contain higher Br concentrations compared to the other area, indicating somewhat different magma sources in the in-axis area and the KR1 mixing area. The Br-rich glasses in the KR1 mixing zone might be explained by a recycled Br-rich oceanic slab of paleo-subduction or by a hydrothermal alteration in the AAR. The K/Cl and K/Ti ratios in the AAR glasses are similar to the basalts from the Galapagos Spreading Center (GSC), a well-known area for an interaction between MOR and hotspot magma (Geldmacher et al., 2010).
The halogens and the trace elements in the basaltic glasses suggest a geochemically complicated upper mantle underneath the AAR.

SEDIMENTARY PROCESSES OF THE CHANNELIZED DEBRIS FLOW DEPOSITS IN THE SPURS FORMATION, THE MARINER GROUP (CAMBRIAN), NORTHERN VICTORIA LAND, ANTARCTICA

Young-Hwan G. Kim[1,2], Jusun Woo[1], Tae-Yoon S. Park[1], Moon Young Choe[1]

[1] Division of Polar Earth-System Sciences, Korea Polar Research Institute, Incheon 406-840, Korea, dave8379@kopri.re.kr
[2] Polar Science, School of Science, Korea University of Sciences and Technology (UST), Daejeon 305-333, Korea

ABSTRACT

A unique cyclic succession of breccia and diamictite occurs in the Cambrian deep-sea sediments (Spurs Formation in the Mariner Group), in the northern Victoria Land, Antarctica. Six columnar descriptions of the debris flow deposit (16 to 22 m in length), of the Spurs Formation at Eureka Spur 3 section, are used to define sedimentary facies and vertical and lateral development of the facies. Two sedimentary facies are distinguished: breccia and diamictite. The breccia facies is composed mainly of clast-supported, unsorted, and disorganized polymictic clasts which are oolite (50%), sandstone (27%), mudstone (18%), and minor limestone (5%). The matrix of breccia is usually composed of ooids, fine sand and minor muddy material. Breccia beds range from 40 to 280 cm in thickness and are 130 cm in average. Most thick beds show lateral variability in thickness and some beds even pinch out. The sedimentary features of the breccia facies represent sedimentation as a result of a 'freezing' of cohesionless debris flows. The diamictite facies is represented by matrix-supported, disorganized, poorly-sorted limestone, sandstone, and mudstone clasts in a muddy matrix which is containing a high-proportion of mud (more than 90%). The size of clasts ranges from a few centimeters to meters in length. These beds are 0.1 to 15 m in thickness. The muddy matrix has cohesive strength, and large clasts may be able to float on the muddy material. High-proportion of mud, ungraded sediments, and deformation structure in the matrix of this facies are suggestive of cohesive debris-flow type deposition. Facies packages of the lower breccia and the upper diamictite form meter-scale fining-upward cycles. A total of 8 cycles are recognized. The lower boundary of each cycle is irregular, sharp, and erosional. The vertical transition from breccia to the overlying diamictite is abrupt with sharp undulate boundary. The cyclic debris flow units show channel-shape architecture with stepped margin. These cycle units are continuous in the channel but onlap or thin out toward the NW channel wall. These cycles are interpreted as cyclic repetition of submarine cohesionless debris flow deposits (breccia) and following cohesive debris flow deposits (diamictite). Understanding the depositional patterns of debris flows is key to understanding and predicting the character of submarine channel-fill deposit.

FINE-GRAINED MELILITE-RICH REFRACTORY INCLUSIONS IN TIL 07003 AND 07007 CV3 CHONDRITES

Hwayoung Kim and Byeon-Gak Choi*

Department of Earth Science Education, Seoul National University, Korea

gadd1013@snu.ac.kr

ABSTRACT

Introduction: Ca-Al-rich inclusions (CAIs) are submillimeter- to centimeter-sized clasts in chondritic meteorites, and composed of refractory minerals predicted to be formed by a condensation of a gas having a solar composition [1]. Textures and mineral assemblages of many CAIs cleary indicate their igneous origin [1-3]. These 'igneous CAIs' are classified into 3 diffrenet types according to their mineralogies: Type A (melilite-dominant), Type B (Al-diopside-dominant) and Type C (anorthite-dominant). The other CAIs that do not seem to be an igneous origin and commonly refered to as 'fine-grained CAIs' [1] are thought to be aggregates of condensates from the solar nebular gas. Although it is widely accepted that the fine-grained CAIs were solid precursors that later melted and crystallized to form the igneous CAIs [2,4], detailed genetic relationships between a variety of different CAIs are still unclear, in part because of limitations caused by a small size of constituent minerals of fine-grained CAIs (< few tens of μm).

In order to better understand the genetic relationships between different types of CAIs, we performed systematic search for CAIs from 7 polished thin sections of two Antarctic reduced CV3 chondirtes, TIL 07003 and TIL 07007 [5,6]. The reduced CV3 chondirtes are known to have the highest abundance of analtered pristine CAIs and thus are suitable for this study. Scanning electron microscope (SEM) and electron microprobe (EMP) were used for observations and analyses of major elements composition of minerals. Three majorities of CAI types were recognized among total 85 CAIs studied: (1) Type A, (2) fine-grained spinel-rich and (3) fine-grained melilite-rich CAIs.

Mineralogy and Texture: Fine-grained CAIs are aggregates of spherically or irregulary shaped nodules having size of 10~100 μm. Each nodule is concentrically zoned, having spinel ± hibonite ± perovskite in the cores which are surrounded by a layer of melilite (and/or anorthite) and an outermost layer of Al-diopside. Anorthite in the fine-grained spinel-rich CAIs appears to replace melilite and the degree of replacement of melilite by anorthite varies from CAI to CAI, thus the mineralogy of fine-grained CAIs covers nearly complete spectrum from almostly anorthite-free to almostly melilite-free. The sequence of layering is spinel → melilite → anorthite → Al-diopside, and no spinels have direct contact with Al-diopside. Fine-grained melilite-rich CAIs are distinguished from fine-grained spinel-rich CAIs by two features: absence of anorthite and abundant occurrence of nodules without spinel in the core.

Type A CAIs contain abundant melilite that poikilitically enclose anhedral to subhedral spinel and

perovskite and that almost completely surrounded by thick layers of Al-diopside. Anorthite and Al-Ti-diopside are also found as minor minerals.

Mineral chemistry: Melilite in all of the CAIs we analyzed is Al-rich (Å $k_{1\text{-}25}$) regardless of CAI types except one fine-grained CAI having relatively Mg-rich melilite (Å $k_{15\text{-}40}$). Average Å k contents of each fine-grained and Type A CAIs vary from 7.7 to 16.3 and from 9.0 to 15.1 repectively, so there is no significant diffrenece in melilite compositions between them. X-ray elemental mapping of Mg Kα shows the melilie-rich interior region of Type A CAIs actually consist of small clusters (10~20 μm in size) that differs in melilite composition and each clusters have compositional reverse zoning of Mg-rich core with Al-rich rim. These reverse zonation is not found within the melilite nodules from the fine-grained melilite-rich CAIs we measured. Bulk composition of fine-grained melilite-rich CAIs acquired by combination of representatitve mineral composition and their modal abundances largely overlaps those of Type A CAIs.

Discussion: Texturally inferred formation sequence of minerals within the fine-grained CAIs we studied (perovskite → hibointe → spinel → melilite → Al-diopside → anorthite) is roughly consistent with the thermodynamically predicted sequence by equilibrium condensation (hibonite → perovskite → melilite → spinel → Al-diopside → anorthite) [7]. The inconsistency between the observation and the predicted sequence of spinel and melilite could be a result of kinetically controlled disequilibrium condensation as suggested by [4,8].

It is plausible that the fine-grained meilite-rich CAIs and Type A CAIs share a common genetic relationship for the following reasons: i) They have identical narrow range of melilite composition. ii) Mineral assemblages of the fine-grained melilite-rich CAIs studied are nearly identical to those suggested as solid precursors of Type A CAIs by previous researches [2,4]. iii) Bulk compositions of fine-grained melilite-rich CAIs largely overlap those of Type A CAIs. Both of them are located on the primary melilite field of spinel projected Ge-An-Fo plane [9] and spinel projected Al_2O_3-Ca_2SiO_4-Mg_2SiO_4 plane [10] of the system CaO-MgO-Al_2O_3-SiO_2 (CMAS). However a complete melting of fine-grained melilite-rich CAIs and subsequent crystallization of melt to form Type A CAIs can not explain the occurrence of spinel and perovskite poikilitically enclosed by melilite because the first mineral predicted to crystallize from this melt is melilite. This consideration leads to prefererence for the formation of Type A CAIs by partial melting of the fine-grained melilite-rich CAIs. The reverse zoning found in melilite and Al-Ti-diopside within the melilite-rich interior could be relicts that surived after partial melting.

Condensation origin of fine-grained melilite-rich CAIs, similarities in melilite composition and bulk composition between fine-grained melilite-rich CAIs and Type A CAIs, occurrence of Al-Ti-diopside as a possible relict mineral in Type A CAIs suggest that the fine-grained melilite-rich CAIs might be the solid precursor of Type A CAIs or, at least, these different two CAI types share a common origin.

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PETROGRAPHIC STUDIES OF GRAPHITE-TROILITE-SILICATE INCLUSIONS IN THE GAPYEONG IAB IRON METEORITE

Hyeong-Gyu Kim, Byeon-Gak Choi*

Department of Earth Science Education, Seoul National University, Korea

kimhyeonggyu@snu.ac.kr

ABSTRACT

Iron meteorites mainly consist of Fe-Ni metals, kamacite and taenite, with various amounts of sulfide, phosphide and carbide as minor phases. Graphite and silicates are also found as inclusions in some groups of iron meteorites, such as IAB and IIE groups. Such inclusions may offer insights about relationships among different meteorites groups and provide additional information regarding the origin and early evolutionary processes of their parent bodies [1-3].

Majority of iron meteorite groups are believed to be fragments of metallic cores of highly differntiated asteroids, especially because the siderophile element compositions of each group can be best understood as the results of fractional crystallization from a well mixed, molten metallic magma [e.g., 4]. However, iron meteorites of IAB-complex have siderophile element compositions that can not be explained by a simple fractional crystallization. Futhermore, IAB irons have silicate-bearing inclusions and some of them are even chondritic in compositions. Various models have been proposed to explain this 'non-magmatic' nature of IAB irons, including crystallization of sulfur- and carbon-rich core in a partially differented body [5,6], breakup and reassembly of a partially differentiated body [2] or crystallization from isolated impact melt pools on the chondritic body [7,8].

Gapyeong iron meteorite found at 1999 is the largest (~180 kg) meteorite found in Korea so far. The meteorite is a medium to coarse octahedrite texturally and a member of IAB group chemically [9]. Similar to previous studied IAB irons, Gapyeong has various types of inclusions in mineralogy and textures. We studied metallic phases and inclusions of the Gapyeong IAB iron meteorite optically and using an electron microscope (JEOL, JSM-6380A SEM at the Seoul National University).

The Gapyeong meteorite mostly consists of Fe-Ni metals (~80 vol. %) with minor amounts of cohenite ($(Fe,Ni)_3C$), schreibersite ($(Fe,Ni)_3P$), troilite (FeS), graphite and silicates. Cohenite and schreibersite are found as swathing minerals around the inclusions described below or along the grain boundaries of Fe-Ni metals, while troilite, graphite and silicates are mostly found as round or irregularly shaped inclusions. Based on mineralogy, the inclusions can be largely divided into (1) troilite-graphite inclusions and (2) graphite-troilite-silicate inclusions. These inclusions are typically surrounded by schreibersite and cohenite. The troilite-graphite inclusions are either circular or round in shape and a few mm to a couple cm in size. Two troilite-graphie inclusions we studied have a texture of breccia. The graphite-troilite-silicates inclusions are irregular in shape and larger than the troilite-graphite inclusions in general. Silicates in these inclusions are olivine ($Fa_{3.6}$), low-Ca pyroxene ($Wo_{1.0}$, $En_{93.2}$,

$Fs_{5.7}$), high-Ca pyroxene ($Wo_{45.5}$, $En_{52.2}$, $Fs_{2.4}$) and plagioclase ($Ab_{88.4}$, $Or_{11.6}$). They commonly occur as subhedral to euhedral crystals of up to 0.7 mm in size.

Mineralogy and textures of the inclusions in Gapyeong meteorite are generally similar to those previously reported [1-3]. For instance, Benedix et al. [2] divided the inclusions in IAB irons into five categories based on shape, mineralogy, composition and textures of silicate minerals: Sulfide rich; nonchondritic; angular, chondritic; rounded, graphite-rich; phosphate-bearing inclusions. However, inclusions having beccia-like texture have not been reported previously. We suspect the inclusions formed by brittle deformation of circular or round shaped troilite-graphite inclusions during impact event. Further details in mineral compositions and texutures of the inclusions will be presented at the meeting.

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PRELIMINARY STUDY OF MINERAL RESOURCES IN NORTHERN VICTORIA LAND, ANTARCTICA

Yeongmin Kim[1], Insung Lee[1], Jong Ik Lee[2], Jusun Woo[2], Won Hyoung Lee[1] and Taewoo Kim[2]*

[1]School of Earth and Environmental Sciences, Seoul National University, Seoul, Korea
[2]Korea Polar Research Institute, Incheon Korea

galgari1@snu.ac.kr

ABSTRACT

On November and December, 2014, Antarctica geological survey was carried out with KOPRI. The study areas are Lichen Hills, Mt. McCarthy, Niagara Icdfalls, Outback Nunatacks and Oakley Glacier. In these areas, granitoids occurred with pegmatite veins, low-grade metamorphosed sedimentary rocks with quartz and Fe-carbonate veins, ultramafic complex composed of dunite, harzburgite and serpentinites, gneiss were sampled. The concentration of trace elements such as REE and uranium in pegmatite vein and granitoids of Lichen Hills will be analized by ICP-MS for uranium resources and REE in monazite. Pyrite and chalcopyrite granis are observed in some quartz vein occurred in Niagara Icefalls area. It is possible that these sulfides can indicate the presence of copper ore deposit in this area. In addition to the presence of copper sulfide, ultramafic complex developed in Niagara Icefalls are main target for mineral resources like chromium. The Mt. McCarthy is located in Bowers Terrane where Glasgow Volcanics and Molar Formation occurred. In this area, metabasalts with numerous quartz and Fe-carbonate veins are observed. Also, quartz veins are identified in metamorphosed sandstone and altered tuff sediment.

TRILOBITE BIOSTRATIGRAPHY OF THE CAMBRIAN SPURS FORMATION AT EUREKA SPURS, NORTHERN VICTORIA LAND, ANTARCTICA REVEALS STRUCTURAL DEFORMATION OF THE AREA

Tae-Yoon S. Park, Ji-Hoon Kihm, Jusun Woo, Young-Hwan G. Kim, Jong Ik Lee, Insung Yoo, Sangbum Park*

Division of Polar Earth-System Sciences
Korea Polar Research Institute, Korea

typark@kopri.re.kr

ABSTRACT

Early Palaeozoic successions of northern Victoria Land, Antarctica are represented by three different tectonic terranes: the Wilson, Bowers, and Robertson Bay terranes, from inboard to outboard. The Bowers Supergroup of the Bowers Terrane is divided into the Sledgers, Mariner, and Leap Year groups in ascending order, and spans the Cambrian Series 3 to the Lower Ordovician. The Mariner Group at Eureka Spurs comprises the Molar, Spurs, and Eureka formations, in ascending order, and has served as the type section of the Mariner Group in northern Victoria Land. The Spurs Formation at Eureka Spurs is 716 m in thickness and is comprised of fissile mudstone with channelized breccias and diamictites, thin-bedded sandstone, and lenses of limestone. Trilobites from only a single horizon of the Spurs Formation have been previously documented, thus providing limited information on the biostratigraphy. During 2012/2013, 2013/2014, and 2014/2015 Antarctic summer seasons, numerous trilobites have been collected from more than ten horizons of the Spurs Formation. The studied interval is characterized by re-occurrences of similar trilobite faunas, indicating that the stratigraphy at this section is somewhat repetitive. Especially, the biostratigraphy of ca. 80 m interval just below the massive 'wedge-like' sandstone is clearly upside-down, suggesting that the 'wedge-like' sandstone must have been derived from structural deformation. This result also reveals that the unusually thick Spurs Formation at Eureka Spurs in the previous stratigraphic reconstruction is due to structural repetition.

RE-EXAMINATION OF ANATOMICAL FEATURES OF FOSSIL WOODS REPORTED BY JEFFERSON ET AL. (1983) AT MESA RANGE, NORTHERN VICTORIA LAND, ANTARCTICA AND CONSIDERATION OF TAPHONOMICAL PROCESS

Changhwan OH[1], Jusun WOO[1], Tae-Yoon S. PARK[1], Jong Ik LEE[1], and Moon-Young CHOE[1]*

[1]Division of Polar Earth-System Sciences, Korea Polar Research Institute, Korea

bluegaia@kopri.re.kr

ABSTRACT

In situ trees engulfed by lavas at Mesa Range areas in northern Victoria Land, Antarctica, were reported by Jefferson et al. (1983), which were identified as conifers, being compared to the fossil-genus *Protocupressinoxylon* Eckhold. However, the report of Jefferson et al. (1983) was mainly of a brief description, and further detailed study was in need. During the 2014/15 season of Korea Antarctic Geological Expedition (KAGEX II), four specimens of the in situ fossil woods engulfed by lavas of the early Jurassic Kirkpatrick Basalt were collected at Mt. Fazio of Mesa Range in northern Victoria Land for re-examination of their anatomical structures. In addition, fossil wood specimens were also collected from the lose blocks near the cliff of Kirkpatrick Basalt. The lava flow unit engulfing the fossil woods in Mt Fazio forms extensive tabular bed with more or less uniform thickness of ca. 20 m. The flow unit overlies a thin sedimentary interbed of mudstone and sandstone to which the lower part of the fossil woods are embedded. The flow unit can be divided into two lithologic units: columnar jointed massive unit and pillow basalt. The lithology near the fossil woods is mostly pillow basalt. This implies most likely that the woods were progressively engulfed by a series of small subaqueous lava flows forming pillows. All fossil woods are silicified and have the characteristics which are rare for the Jurassic woods, such as: 1) poorly defined and widely spaced growth rings, 2) absence of normal and traumatic resin canals, 3) usually araucarioid or sometimes abietinean radial tracheids pitting, 4) at least, locally scalariform radial tracheid pitting, 5) uniseriate, partly biseriate or rarely full biseriate rays, 6) presence of distinctly pitted horizontal walls of rays, 7) presence of *Abietineentüpfelung* or sometimes *Juniperustüpfelung* on tangential walls of rays, and 8) taxodioid, cupressoid or somewhat araucarioid type cross-field pitting. Based on these characteristics, fossil woods in Mt. Fazio are distinguished from *Protocupressinoxylon*. Instead, they show similarities with other fossil-genera, such as *Protojuniperoxylon* Eckhold, *Planoxylon* Stopes, *Sahnioxylon* Bose et Sah, and *Ecpagloxylon* Philippe, Cuny et Bashforth. However, more detailed study is required for the precise taxonomy and the phylogenetic position. Further study on the fossil wood specimens is expected to provide new information on the wood flora and palaeoenvironment in Antarctica during the Jurassic time.

PREDICTING THE IMPACT OF LAVA FLOWS AT MT. MELBOURNE

Jihwan Park

*Jihwan Park[1], Huiuk Yi[1], Sung-Min Kim[1], Myeongchan Oh[1] and Hyeong-Dong Park[1]**

[1]Seoul National University, Korea

atria@snu.ac.kr

ABSTRACT

Recently gas emission and thermal activity were detected at Mt. Melbourne, which is located 30 km north from Antarctic Jang Bogo Station. These phenomena can be recognized as precursor of volcanic eruption. Because the distance between the mountain and the station is not far, predicting the impact and damage area of future eruption is important to safety of residents in the station. Here, lava flow invasion susceptibility map was presented based on GIS computational simulation. The geographic information including location of the station and mountain and digital elevation model (DEM) of the study area was used as input data, and multiple flow direction (MFD) method were used to simulate the movement of lava flow. The lava is predicted to flow to all directions, but finally to reach the south-western, north-western and northern coasts. The result of the study predicts that there would be no damage to the station. The susceptibility map can provide the safe and hazardous zone to researchers.

2014 GEOLOGICAL FIELD SURVEY ON THE WILSON TERRANE LITHOLOGIES NEAR THE JANG BOGO STATION, NORTHERN VICTORIA LAND, ANTARCTICA, AND THE PRELIMINARY STUDY ON ECLOGITE-FACIES METAMORPHIC ROCKS FROM THE LANTERMAN RANGE

Taehwan Kim[1], Moonsup Cho[1], and Jong Ik Lee[2]

[1] School of Earth and Environmental Sciences, Seoul National University, Seoul 151-747, Korea
[2] Division of Polar Earth-System Sciences, Korea Polar Research Institute, Incheon 406-840, Korea

ABSTRACT

We carried out geological field survey in and around the Jang Bogo Station (JBS), Northern Victoria Land (NVL), during the 2014 summer season. A variety of rock samples were collected from the Wilson Terrane, including high-pressure (HP) rocks at the Lanterman Range and medium-pressure migmatitic gneisses widespread in the vicinity of the JBS. In this study, we showcase our field work in the Antarctica and report preliminary results on the Lanterman HP rocks.

The Lanterman HP assemblages comprise mafic eclogites and phengite-rich host gneisses and limitedly occur along the suture between two tectonic provinces in the NVL, the Wilson and Bowers terranes. This suture records the top-to-the-east thrusting event overprinted by sinistral strike-slip movement. Eclogites and eclogitic amphibolites occur as boudins or pods intercalated in felsic gneisses or schists. The eclogite-facies metamorphism is attributed to a subduction to ultrahigh-pressure (UHP) depths during the Ross Orogeny dated at ca. 500 Ma by earlier workers.

The mafic eclogites are either massive or foliated; the compositional layering in foliated eclogite is primarily defined by prismatic omphacite together with elongate-shaped garnet. Rutile and quartz occur as minor phases. The majority of garnet grains, $Alm_{0.44}Prp_{0.32}Grs_{0.22}Sps_{0.02}$ in average composition, are euhedral to subhedral and < 2 mm in size. Radial fractures are rarely present in garnet. Discontinuous zoning with yellowish grossular-rich cores is characteristic, and the core region contains fine-grained inclusions such as omphacite, rutile, quartz, zircon, and apatite together with rare epidote. Omphacite contains the 45 mol. % jadeite–acmite component [Na/(Ca + Na) = 0.45] and commonly preserves irregular-shaped Fe-richer core. Anhedral poikiloblasts of barroisite commonly enclose the eclogite-facies minerals, indicating a post-peak growth. Thus, HP to UHP peak metamorphic ages previously dated from the Sr-Nd isochron of barroisite and other phases, may represent the post-peak metamorphism or the eclogite to amphibolite transition during the exhumation stage. Thus we plan to further constrain the timing of prograde, peak, and retrograde metamorphism based on the SHRIMP U-Th-Pb ages of zircon and monazite.

The phengite-rich host gneiss or garnet–phengite quartzite is well foliated by the alignment of phengite and biotite. Other primary minerals include plagioclase and quartz, whereas accessory phases

are epidote, apatite, and Fe–Ti oxide. Biotite and plagioclase (ca. An_{15}) only occur as patch-type symplectites mantling phengite, suggesting a metasomatic replacement associated with the growth of epidote neoblasts. The growth of epidote and oligoclase indicate a medium-pressure amphibolite-facies retrogression.

PETROGRAPHY, GEOCHEMISTRY, AND AGE OF A GRANOPHYRE CLAST IN THE LUNAR METEORITE DEW 12007

Jeong Han[1,2], Jong Ik Lee[2], Changkun Park[2], Mi Jung Lee[2], Taehoon Kim[2], Jeongjin Moon[2], Keewook Yi[3], Sung-Tack Kwon[1]*

[1]Department of Earth System Science, Yonsei University, Seoul, Korea
[2]Korea Polar Research Institute, Incheon, Korea
[3]Korea Basic Science Institute, Ochang, Korea

jh1018@yonsei.ac.kr

ABSTRACT

Lunar meteorites provide constraints on igneous processes of the Moon. A thin section (JK-1) of the lunar meteorite DEW 12007, a mingled regolith breccia (Collareta et al., 2014), contains seven large clasts in a gabbroic matrix: a granophyre, three basaltic breccias, two olivine norites, and a basaltic glassy melt. Here we present petrographic, geochemical and geochronologic information for the granophyic clast (C3).

C3 is an oval-shaped (~4.0 x ~1.8 mm) rock fragment with dense microfractures. The main texture is a granophyric intergrowth mostly of barian alkali-feldspar ($An_{1.2\text{-}13.1}Ab_{17.4\text{-}41.1}Or_{46.0\text{-}76.2}Cn_{0.4\text{-}11.5}$) and silica, and much lesser amount of sodic plagioclase ($An_{27.0\text{-}37.1}Ab_{61.3\text{-}71.5}Or_{0.7\text{-}1.7}Cn_{0.0\text{-}0.5}$) and silica. "Ternary feldspar" ($An_{11.1\text{-}39.0}Ab_{33.6\text{-}55.7}Or_{11.6\text{-}53.8}Cn_{0.0\text{-}2.6}$) is distributed in small amounts, which refers to crystalline feldspar with intermediate compositions between alkali-feldspar and plagioclase. Olivine (Fa_{90}) crystals are subhedral to anhedral. Minor phases include needle-shaped ilmenite, tranquillityite, merrillite and apatite, and skeletal zircon. Troilite, baddeleyite, and monazite are trace (<0.1 vol. %). Comparing to other lunar granites (Meyer et al., 1996; Ryder et al., 1975; Seddio et al., 2013; Warren et al., 1983), C3 shows distinct mineralogy and chemistry. There are twelve mineral phases of magmatic origin. Alkali-feldspars contain a wide range of BaO concentrations (0.21-6.03 wt. %). Furthermore, the bulk composition of C3 estimated from the modal analysis is characterized by high SiO_2 (74.76 wt. %) and BaO (1.26 wt. %), and low CaO (0.89 wt. %). SHRIMP U-Th-Pb isotopic data (n=16) for five zircon grains give the upper intercept age is 4340.2 ± 7.5 (1σ) Ma and the weighted mean of ^{207}Pb-^{206}Pb ages is 4332.4 ± 1.6 (2σ) Ma.

Assuming the parent magma had basaltic compositions (Seddio et al., 2013), the intergrowth of alkali-feldspar and silica, fayalitic olivine cooccurred with silica, sodic plagioclase, and the high bulk SiO_2 concentration of C3 indicate high degree of magmatic differentiation. These textural and chemical features of C3 have a close affinity with granophyres crystallized at the late stage of fractionation in layered mafic intrusions (e.g. The Bushveld Igneous Complex) on the Earth, proven to be the silicate liquid immiscibility of highly fractionated basaltic melt (VanTongeren and Mathez, 2012). We will test liquid immiscibilitiy model and other possibilities for C3 formation and the results will be given at the meeting.

POSTER SESSION

Remote Sensing of the Changing Globe I (Marine), II (Terrestrial)

VARIABILITY OF THE ANTARCTIC COASTAL CURRENT AND ITS CAUSES IN THE AMUNDSEN SEA

Chang-Sin Kim[1], Tae-Wan Kim[1], Kyong-Ho Cho[1], Heewon Yang[1], SangHoon Lee[1] and Jae-Hak Lee[2]

[1]Korea Polar Research Institute, Incheon 406-840, South Korea
[2]Korea Institute of Ocean Science and Technology, Ansan 425-600, South Korea

ABSTRACT

The Antarctic Coastal Current (AACC) or east wind drift flows westward around Antarctica. Coastal current makes dynamic barrier and keeping Warm Deep Water by depressing the thermocline (Ismael and Fahrbach, 2009). The AACC is mainly barotropic component by the wind driven Ekman transport (Sverdrup 1953) and baroclinic component is generated by a density gradient between Antarctic Surface Water (AASW) and Shelf Water (Fahrbach et al., 1992). Ismael and Fahrbach (2009) show the contribution of the mechanisms driving the coastal current and its seasonality in the Weddell Sea. Therefore, the present study attempts to quantify the contribution of the mechanisms driving the AACC and its seasonality and decadal variation of coastal current in the Amundsen Sea.

We evaluated variability of coastal current and its driving forcing in the Amundsen Sea using observation and calculated ocean current. The observation data was collected here was obtained from KOPRI mooring stations in the Dotson Trough, which is one of the deep troughs in the Amundsen shelf. The velocity and hydrographic data were obtained using Recording Current Meter 9/11 and SBE 37 MicroCAT CTD. The velocity and hydrographic data was collected with a frequency of one measurement each 1 hour from February 2012 to January 2014. Ekman transport is mainly due to local wind. Therefore, the surface atmospheric forcing was analysis National Centers for Environmental Prediction Climate Forecast System Version 2 (NCEP CFSRv2). Sea ice concentration influences the exchange of stress between wind and current by the modified the surface drag coefficient. Therefore, the sea ice concentration is collected by Special Sensor Microwave Imager/Sounder (SSMIS). The observations of AACC are compared with possible forcing. The westward current shows in front of the Dotson ice shelf (DIS) and it strong seasonal variation. The seasonality of the AACC was well matched with the seasonality of the pressure gradient in the Dotson Trough (DT).

VARIABILITY OF ADCP BACKSCATTERING SIGNALS CAPTURED BY LONG-TERM MOORINGS: AMUNDSEN SHELF, ANTARCTICA

Ho Kyung Ha[1], Hyoung Sul La[2], Tae Wan Kim[2], A.K. Wåhlin[3], Hyoung Chul Shin[2]

[1]Department of Ocean Sciences, Inha University, South Korea
[2] Korea Polar Research Institute, South Korea
[3]Department of Earth Sciences, University of Gothenburg, Sweden

hahk@inha.ac.kr

ABSTRACT

Using a series of bottom-moored, upward-looking acoustic Doppler current profilers (ADCPs), high-temporal resolution profiles of acoustic backscatter were collected in the Amundsen Shelf. All mooring systems with ADCP have been installed and recovered by a coherent international collaboration between Korea and Sweden. The long-term (4 years) time series of mooring data was analyzed to investigate the seasonal and interannual variabilities in sea ice concentration (SIC) and Circumpolar Deep Water (CDW) thickness on acoustic backscatter. The depth of maximum mean volume backscattering strength (MVBS) showed a significant correlation with SIC and CDW thickness. From 2010 through 2014 year, the MVBS measured by ADCP gradually decreased, which corresponded to the decreading trend of Chl-a. The daily cycle in the vertical distribution of acoustic backscatter varied distinctly with changing surface ice conditions. When sea ice cover was low, acoustic backscatter was associated with sunlight's daily cycle. The acoustic backscatter descended and ascended at sunrise and sunset, respectively. In contrast, when sea ice cover was high, high acoustic backscatter remained near the bottom. During the presentation, in-depth discussion on how the external forcings (e.g., wind, SIC, and current) can control the vertical motion of backscatter strengths and their seasonal and interannul variabilities will be dealt with.

TEMPORAL AND SPATIAL VARIABILITY OF ROSS SEA POLYNYA USING MULTI-SATELLITE OBSERVATIONS

Young Heon Jo

Jinku Park[1], Young Heon Jo[1], Hyun Cheol Kim [2]*

[1] Department of Oceanography, Pusan National University, Busan Korea
[2]Korea Polar Research Institute, Incheon Korea

jkpark0221@pusan.ac.kr

ABSTRACT

Polynya has been known determined as the region of opening in the middle of packed ice. These features can be classified as sensible and latent heat polynya, according to trait of heat exchange. The latent heat polynya predominantly occurs in coastal areas and formed by moving away sea ice off the coast by a strong 'katabatic wind' that blowing out from the continent. The seawater on the surface becomes close to at freezing point by interaction with cold air over the polynya and pushed out to the edge of the polynya as soon as it formed. During this process the latent heat is released into the atmosphere.
The Ross Sea, our study area, is located at the edge of the north Ross Ice Shelf which is the largest ice shelf in the Antarctica. It has a large latent heat polynya (called for Ross Sea polynya; hereafter RSP) that has been studied by many researchers. The previous studies reported that these features affect or impact the regional and global climate change directly or indirectly. Therefore, it is necessary to understand the variation of polynyas in order to identify and predict a regional or global environmental change. Here, we focused on the spatio-temporal variability of RSP through a physical perspective.
For our purposes, we used sea ice concentration product from the Special Sensor Microwave Imager (SSM/I) and the Special Sensor Microwave Imager/Sounder (SSMIS) during 1988 and 2013 and also the European Centre for Medium-Range Weather Forecasts (ECMWF) for wind. In order to estimate long term trend, the Ensemble Empirical Mode Decomposition (EEMD) method is employed. EEMD has a feature that can be separated in to several different frequency signals which have physical meaningful.

CHARACTERISTIC OF ANTARCTIC CIRCUMPOLAR CURRENT AROUND THE ROSS SEA

Jang-Geun Choi

Yejin Oh[1], Jang-Geun Choi[1], Jinku Park[1] and Young-Heon Jo[1]*

[1]Department of Oceanography, Pusan National University, Busan, 609-735, Republic of Korea

oyj1115@nate.com

ABSTRACT

The Antarctic Circumpolar Current (ACC) is a return current, which has rotated in a clockwise around the Antarctica, which plays a important role in exchanging heat and salinity in the Antarctic Sea. The main stream of ACC is modulated by continuous prevailing westerlies and bathymetry changes.

In order to investigate an effects of the variability of ACC off the Ross Sea and relationship with Ross Sea Polynya dynamics, we analyzed patterns of ocean circulation in austral summer(January ~ March) from 1993 to 2013, when the areas of polynya expands in maximum, using a tracer tracking method based on the lagrangian flow fields.

We calculated new current components (u and v) using geostrophic current data from AVISO, 10 meter wind components of ECMWF (European Centre for Medium-Range Weather Forecasts) and bathymetry data product obtained from ETOPO-1 based on the theory of Welander (1956). Then, we allowed some tracers in the combined flow fields of Gestrophic and Ekman current in the inner and the outer parts of the Ross Sea Polynya and observed how the Lagrangian flow shows the tracers, suggesting that how much energy is exchanged with and without Polynyas.

In order to validate the estimated trajectories, satellite-tracked surface drifter buoys of GDP (Global Drifter Program) from NOAA/AOML (Atlantic Oceanographic & Meteorological Laboratory of NOAA) were compared.

HIGH SALINITY SHELF WATER FORMATION IN RESPONSE TO ATMOSPHERIC FORCING OF THE TERRA NOVA BAY POLYNYA, ANTARCTICA

Christopher J. Zappa

Christopher J. Zappa[1], Deborah A. Le Bel[1], Arnold L. Gordon[1], and Giorgio Budillon[2]*

[1] Lamont-Doherty Earth Observatory, Ocean and Climate Physics, Columbia University, P. O. Box 1000, 61 Route 9W, Palisades, NY 10964, USA.
[2]Università degli Studi di Napoli Parthenope, Centro Direzionale, Isola C4 – 80143 Naples, Italy

zappa@ldeo.columbia.edu

ABSTRACT

Dense High Salinity Shelf Water (HSSW), a key component of Antarctic Bottom Water emanating from the Ross Sea, is intensified by brine rejection induced by ice formation within the Terra Nova Bay (TNB) polynya. Hydrographic data reveal HSSW freshening of approximately -0.005 yr^{-1} since the 1980s, nearly twice the rate of freshening in the southwest Ross Sea. Meteorological observations from Automatic Weather Stations in conjunction with ocean mooring data from 2007 and a satellite-derived history of the opening of TNB polynya delineate higher-frequency water column salinity variability linked to atmospheric forcing. Lagged correlation analysis indicates that salinity response lags the polynya opening by two days and the wind forcing by four days. Maximum HSSW salinity occurs after the katabatic wind event, as polynya closes. The response time of HSSW to the polynya opening may be expected to vary with the initial stratification within TNB, which would have seasonal and likely interannual variability imposed by regional oceanography and sea ice factors.

MARGINAL ICE ZONE PROCESSES OBSERVED FROM UNMANNED AERIAL SYSTEMS

Christopher J. Zappa

Christopher J. Zappa[1], Scott M. Brown[1], Sophia E. Brumer[1], Deborah A. Le Bel[1], and Tejendra Dhakal[1]*

[1] Lamont-Doherty Earth Observatory, Ocean and Climate Physics, Columbia University, P. O. Box 1000, 61 Route 9W, Palisades, NY 10964, USA.

zappa@ldeo.columbia.edu

ABSTRACT

Recent years have seen extreme changes in the Arctic. Marginal ice zones (MIZ), or areas where the "ice-albedo feedback" driven by solar warming is highest and ice melt is extensive, may provide insights into the extent of these changes. Furthermore, MIZ play a central role in setting the air-sea CO_2 balance making them a critical component of the global carbon cycle. Incomplete understanding of how the sea-ice modulates gas fluxes renders it difficult to estimate the carbon budget in MIZ. Here, we investigate the turbulent mechanisms driving mixing and gas exchange in leads, polynyas and in the presence of ice floes using both field and laboratory measurements.

Here, we present measurements of visible and IR imagery of melting ice floes in the marginal ice zone north of Oliktok Point AK in the Beaufort Sea made during the Marginal Ice Zone Ocean and Ice Observations and Processes EXperiment (MIZOPEX) in July-August 2013. The visible and IR imagery were taken from the unmanned airborne vehicle (UAV) ScanEagle. The visible imagery clearly defines the scale of the ice floes. The IR imagery show distinct cooling of the skin sea surface temperature (SST) as well as an intricate circulation and mixing pattern that depends on the surface current, wind speed, and near-surface vertical temperature/salinity structure. Individual ice floes develop turbulent wakes as they drift and cause transient mixing of an influx of colder surface (fresh) melt water. We capture a melting and mixing event that explains the changing pattern observed in skin SST and is substantiated using laboratory experiments.

Recent measurements in a region of the Fram Strait and Greenland Sea northwest of Ny-Å lesund, Svalbard, Norway will also be presented from our Air-Sea-Ice Physics and Biogeochemistry Experiment (ASIPBEX), the Lamont Doherty Earth Observatory (LDEO) component of the Coordinated Investigation of Climate-Cryosphere Interactions (CICCI-3) from 13 April – 4 May 2015. Several new payloads have been developed for use on the NOAA/PMEL Manta UAS. We have improved our visible and infrared imaging payload to provide precise measurements of ice/snow/ocean surface temperatures accurate to 0.1°C. We have also developed a number of new payloads that include: i) hyperspectral aberration-corrected imaging spectrometers to measure VNIR (400-1000 nm) and NIR (900-1700 nm) spectral radiance of the upper-ocean and sea ice to determine ocean color, ice-age

distributions and ice-surface type; ii) up- and down-looking hemispheric pyrgeometers and pyranometers to measure the net longwave and net shortwave radiation for ice-ocean albedo studies with an onboard visible camera to determine the sea ice fraction and whitecapping; iii) meteorological measurements of the turbulent momentum, sensible, and latent fluxes as well as wave height, ice freeboard, and surface roughness with a LIDAR; iv) four dropsonde-microbuoys (DMB) deployed from the Manta. The DMB measures temperature, pressure, and relative humidity as it descends through the atmosphere. Once it lands on the ocean's surface, it deploys a string of sensors that measures temperature and salinity of the upper three meters of the ocean. The ocean sensors telemeter data back to the UAS on subsequent flights. The DMB can also be dropped on an ice flow to measure the rate of the ice movement. The DMB collect and store data and then transmit the data back to the UAS when it comes overhead. Details of these payloads and example data from ASIPBEX will be reported.

The Gas Transfer through Polar Sea Ice experiment was performed at the US Army Cold Regions Research and Engineering *Laboratory (Hanover, NH*) under varying ice coverage, winds speed, fetch and currents. Supporting measurements were made of air and water temperature, humidity, salinity and wave height. Air-side profiling provided momentum, heat, and CO_2 fluxes. Transfer velocities are also estimated via the active controlled flux technique. Surface turbulence statistics derived from PIV and optical flow applied to infrared imagery are linked to subsurface turbulence and used to investigate how turbulent mechanisms at the ice-water boundary including shear and buoyancy contribute to the magnitude of the transfer. Gas exchange variability with lead size and enhancement near floes will be examined.

REMOTE SENSING EFFORTS IN ONR MIZ PROJECT

Byongjun Hwang

Byongjun Hwang[1], Craig Lee[2], Hans Graber[3], Sung-Ho Kang[4], Kyoung-Ho Cho[4], Axel Schweiger[2], Jeff Pietro[5], Jeremy Wilkinson[6], Martin Doble[7], Mary Jane Perry[8], Richard Krishfield[5], Shawn Gallaher[9], and Timothy Stanton[9]*

[1]Scottish Association for Marine Science, Oban, UK
[2]APL, University of Washington, Seattle, USA
[3]CSTARS, University of Miami, Miami, USA
[4]Korea Polar Research Institute, Incheon, Korea
[5]Woods Hole Oceanographic Institution, Woods Hole, USA
[6]British Anartic Survey, Cambridge, UK
[7]UPMC-LOV, Nice, France
[8]SMS, University of Maine, Orono, USA
[9]Naval Postgraduate School, Monterey, USA

phil.hwang@sams.ac.uk

ABSTRACT

Since 2013 KOPRI and ONR MIZ team have been building strong collabrations, which led to very successful KOPRI-MIZ ice camp in 2014 on board *Araon*. The MIZ project has very strong autonomous observing platform components, such as gliders, ITPs, AOFBs, and wave and ice buoys, and also has a strong remote sensing component. This includes intensive coverage by various satellite data, ranging from 1-m resolution optical satellite dat, high resolution TerraSAR-X, to large scale Radarsat-2 Synthetic Aperture Radar (SAR) data and MODIS optical and IR images. These satellite data have been acquired fellowing autonomous observing platforms as well as at the KOPRI-MIZ ice camp, providing detailed information on chaning sea ice conditions. By combining satellite data with autonomous observing platforms, we can capture a more complete picture of physical mechanisms involved in the seasonal transition of the marginal ice zone. Our presentation will include an overview of satellite remote sensing efforts within MIZ project and some of the analysis results of satellite data.

SURFACE MELTING OF SEA ICE AND MELT POND OBSERVED BY SPACEBORN HIGH-RESOLUTION IMAGING DATA

Jeong-Won Park, Hyun-Cheol Kim, Sang-Hoon Hong, and Sung-Ho Kang*

Korea Polar Research Institute, Korea

jeongwonpark@kopri.re.kr

ABSTRACT

Melt ponds are issued because they accelerate the melting of sea ice in the warmer months of spring and summer. It has known that the melt ponds assorb solar radiation rather than reflecting it as surrounding sea ice does. However, the size and distribution of melt pond is highly variable so that the contribution of melt pond on sea ice melting process would be differ by the maturity of melt pond. Due to the harsh condition of Arctic area, it is not easy to estimate the actual surface changes over the melting period by in-situ measurement and/or optical remote sensing data. In this study, we present the very first time series analysis for short-term variation of sea ice and melt ponds over Beaufort Sea using spaceborne multispectral and SAR images. The KOMPSAT-3 image was used for initial classification of surface types, and TerraSAR-X images covering 46 days in 2014 Arctic summer were used for time-series analysis. The surface of target sea ice was classified into 6 classes by spectral characteristics. The temporal variation of radar backscattering coefficient in each class showed distinct pattern, which is closely related to the surface melting rate. Overal trend reflected continuous surface melting except over pressure ridges. Snow covered ice surfaces showed much less changes compared to bare ice surfaces. The surfaces adjacent to pond showed stronger negative trend than other classes. Especially, the change rate of shallow melt pond (blue pond) showed linear trend, which is significantly different from the non-linear trend of deep melt pond (dark pond). This observation supports the albedo-feedback mechanism. The estimated rate and pattern of melting can be importantly used for computing surface melting rate and inferring the variation over large area by remote sensing data.

NUTRIENTS IN MELT PONDS AND SNOWS ON ARCTIC SEA ICE DURING 2014 SEA ICE CAMP

Jinyoung Jung

Jinyoung Jung[1], Jun-Oh Min[1], Eun Jin Yang[1], Sang H. Lee[2] and Sung-Ho Kang[1]*

[1]Korea Polar Research Institute, Incheon Korea
[2]Pusan National University, Busan Korea

jinyoungjung@kopri.re.kr

ABSTRACT

Melt ponds are the most distinctive summertime feature of Arctic sea ice, which are formed by melting snow and surface sea ice due to surface melt driven by increased short-wave radiation absorption in summer. Although considerable effort has been devoted to investigate physical processes and feedbacks of melt ponds, relatively little is known about biogeochemical properties of melt ponds. To examine chemical components of nutrients (NH_4, NO_2+NO_3, PO_4 and SiO_2) in different types of melt ponds (i.e., closed and opened ponds) and differences of nutrients in between melt ponds and snows near melt ponds, a total of 36 melt ponds and snow samples were collected at two different sea ice stations located in northern part of the Chukchi Sea during the ARA05B cruise aboard Korean icebreaker *Araon*. In the closed melt ponds (salinity ≈ zero), NH_4 and NO_2+NO_3 showed high concentrations, whereas PO_4 concentrations were low and SiO_2 was not detected. In contrast, in the opened ponds (salinity ≈ surface seawater), both nitrogen species were depleted as those in surface seawater, while PO_4 and SiO_2 concentrations were as high as those in surface seawater. In snow samples, mean NH_4 concentration was about 9 times higher than that of NO_2+NO_3, probably due to NO_2 and NO_3 losses in snows by photolysis. Likewise SiO_2 in the closed ponds, SiO_2 in snow samples was not detected. From these results, it was suggested that not only salinity, but also nitrogen species, especially NH_4, and SiO_2 can be used as an indicator to distinguish between the closed and opened ponds, and that high NH_4 concentrations in the closed ponds were derived from snows. In addition, all nutrients species concentrations in surface and deep waters of the opend ponds showed large differences, suggesting that the melt pond waters were strongly stratified. Although no statistically significant relationships were found between chlorophyll a and nutrients variation trends, chlorophyll a concentrations in both types of melt ponds were higher than those in surface seawater, implying that additional nutrients supplied to the melt ponds from snows might contribute to more high biological acitivities in the melt ponds. Considering that the Arctic Ocean is currently experiencing rapid environmental change, such as warming and decreases in sea ice concentration and thickness, the role of melt ponds could be important. Further studies on biogeochemical cycles in the melt ponds therefore are required to improve understanding of the Arctic marine ecosystem more clearly.

BIOGEOCHEMICAL CHARACTERISTICS OF NUTRIENTS, DISSOLVED AND PARTICULATE ORGANIC MATTERS IN THE AMUNDSEN SEA

Jinyoung Jung

Jinyoung Jung[1], Sun-Yong Ha[1], Eun Jin Yang[1], Kyung-Hoon Shin[2] and SangHoon Lee[1]*

[1]Korea Polar Research Institute, Incheon Korea
[2]Hanyang University, Ansan Korea

jinyoungjung@kopri.re.kr

ABSTRACT

The Amundsen Sea is one of the regions where ice sheet thinning is the fastest in Antarctica, which is mainly attributed to the intrusion of Circumpolar Deep Water (CDW) through deep troughs onto the Antarctic continental shelf. In addition, the Amundsen polynya is the most productive among those identified along the Antarctic coast. These features make the Amundsen Sea an ideal location to monitor the influence of environmental changes on marine biogeochemical cycles. Nevertheless, no study has been carried out over this region to investigate carbon and nitrogen biogeochemical cycles, simultaneously. Seawater samples were collected over the Amundsen Sea in January 2014 aboard Korean icebreaker *Araon*, and analyzed for nutrients (NO_3, PO_4, NH_4, SiO_2), dissolved and particulate organic carbon (DOC and POC) and nitrogen (DON and PON). Despite the exceedingly high biological production in the Amundsen polynya, NO_3 and PO_4 in surface water were not totally depleted, suggesting that remineralization is fast enough to maintain their concentrations, and/or that biological production is limited by other factors such as iron. DOC and POC concentrations ranged from 38–73 μM C and < 1–60 μM C, respectively. Both DOC and POC concentrations increased in the upper 100 m of the water column. However, below 100 m POC concentration remained low (< 3 μM C) when DOC concentration varied from 38–69 μM C. Likewise, DON concentrations deeper than 100 m increased by 7 μM N while NO_3 concentrations were distributed homogeneously. These results suggest that the biological drawdown of inorganic nutrients result in the net production of organic matter in the upper 100 m, and that sinking particle flux would be low because of remineralization of particulate matter by grazing and microbial activity.

ESTIMATION OF NET COMMUNITY PRODUCTION IN THE AMUNDSEN SEA POLYNYA: SELF-ORGANIZING MAP ANALYSIS APPROACH

Keyhong Park[1], Doshik Hahm[1], Tae Siek Rhee[1], Hyun-cheol Kim[1]

[1] Division of Polar Ocean Environment, Korea Polar Research Institute, Incheon 406-840, South Korea

ABSTRACT

The Amundsen Sea, Antarctica, has been known for one of the most susceptible region to the current climate change such as sea ice melting and sea surface temperature change. In the Southern Ocean, a predominant amount of primary production is occurring in the continental shelf region. Phytoplankton blooms take place during the austral summer due to the limited sunlit and sea ice cover. Thus, quantifying the variation of summer season net community production (NCP) in the Amundsen Sea Polynya is essential to analyze the influence of climate change to the variation of biogeochemical cycle in the Southern Ocean. During the two years of 2011, and 2012 in austral summer, we have derived NCP of the Amundsen Sea Polynya from the underway measurements of $\Delta O_2/Ar$. Despite the importance of NCP for understanding biological carbon cycle of the ocean, the observations are rather limited to understand the spatio-temporal variation in the Amundsen Sea. Thus, we applied self-organizing map (SOM) analysis to expand our observed data sets and estimate the NCP during the summer season (December, January, and February; DJF). In this study, we estimate 2010 – 2011 and 2011 – 2012 DJF NCP for every 8-day and find a variables set optimally delineates the NCP variation in the Amundsen Sea Polynya as well.

SOURCE CHARACTERIZATION OF CARBON MONOXIDE AND OZONE OVER THE NORTHWESTERN PACIFIC IN SUMMER 2012

Keyhong Park[1], Tae Siek Rhee[1]*

[1]Korea Polar Research Institute, Korea

ABSTRACT

Carbon monoxide (CO) and ozone (O3) were continuously measured in the marine boundary layer of the East Sea, the Northwestern Pacific, and the Bering Sea onboard R/V Araon in the second halves of July and September of 2012, as a part of the SHIpborne Pole-to-Pole Observations (SHIPPO) program. Depending on the characteristics of each section of the cruise track, up to 66 ppbv and 17 ppbv of CO and O3 variability were observed, respectively. The O3/CO ratio suggests that O3 was dominantly produced by photochemical reactions in the troposphere, although in the northern sections of the cruise track, the ratio likely suggests vertical transport from the free troposphere or the lowermost stratosphere. To analyze the source characteristics and the transport of both trace gases, a tagging technique in a 3-D global chemical transport model (Model for OZone And Related chemical Tracers-4; MOZART-4) was applied. The model reproduced the observations fairly well, and the technique enabled us to characterize the source regions and composition of the observed CO. Anthropogenic emissions from Northeastern Asian countries appeared to be substantial sources of the CO in the southern sections, and biomass burning in Siberia was an important source of the CO observed in the northern sections of the cruise track. Long-range transport of anthropogenic CO emissions was distinct over the Bering Sea, where the comparable contributions from North America, Northeast Asia, and Europe were identified. Low CO events driven by southern hemispheric invasion were encountered at the southern coast of the Korean peninsula and in the North Pacific at ~50N latitude. The model pointed to a noticeable contribution from the open ocean in the Southern Hemisphere for these events.

SINKING PARTICLE FLUX AND ORGANIC CARBON SEDIMENTATION ON THE AMUNDSEN SHELF, ANTARCTICA

Minkyoung Kim

Minkyoung Kim[1], Jeomshik Hwang[1], Hyung J. Kim[2], Dongseon Kim[2], Eun J. Yang[3], Hugh W. Ducklow[4], Hyung S. La[3], Sang Heon Lee[5], Jisoo Park[3], and SangHoon Lee[3]*

[1]Seoul National University, Seoul, Korea
[2]Korea Institute of Ocean Science & Technology, Ansan, Korea
[3] Korea Polar Research Institute, Incheon, South Korea
[4] Lamont-Doherty Earth Observatory, Columbia University, NY, USA
[3] Pusan National University, Pusan, Korea

mini324@snu.ac.kr

ABSTRACT

We have examined the flux, biogenic composition, and isotopic values of sinking particles collected by a time-series sediment trap deployed in the sea ice zone (SIZ) of the Amundsen Sea from January 2011 for 1 year. The major portion of the particle flux occurred during the austral summer in January and February when sea ice concentration was reduced to <60 %. Biogenic components, dominated by opal, accounted for over 75 % of particle flux during this high-flux period. The dominant source of sinking particles shifted from diatoms to soft-tissued organisms, evidenced by high particulate organic carbon (POC) content (>30 %) and a low bio-Si/POC ratio (<0.5) during the austral winter. When compared with POC flux inside the Amundsen Sea polynya obtained by the US ASPIRE, the POC flux integrated over the austral summer in the SIZ was virtually identical, although the maximum POC flux was approximately half that inside the Amundsen Sea polynya.

Temporal variation in recent history of sedimentary organic carbon (SOC) accumulation has also been examined mainly based on radiocarbon analysis of bulk SOC. Vertical profiles of SOC content, carbon isotopes in the upper 21-cm sediment horizons were obtained at four locations in the western Amundsen Sea (near the shelf break, at the periphery and at the center of the Amundsen Sea polynya, and inside the polynya near the Dotson Ice Shelf). The SOC content and radiocarbon content of surface sediments were generally consistent with the spatial distribution of primary productivity in the surface water. SOC accumulation rate were several-fold higher in the polynya region. About 90 % of SOC accumulation occurs in the polynya on the western Amundsen shelf.

THE DISTRIBUTION OF GLACIAL MELTWATER IN THE AMUNDSEN SEA, ANTARCTICA, REVEALED BY EXCESS HELIUM AND NEON

Intae Kim*, *Doshik Hahm, Tae Siek Rhee, Tae Wan Kim, Chang-Sin Kim, and SangHoon Lee*

*Korea Polar Research Institute (KOPRI), Division of Polar Ocean Environment, Incheon 406-840, South Korea (*Presenting Author: ikim@kopri.re.kr)*

ikim@kopri.re.kr

ABSTRACT

The light noble gases, helium (He) and neon (Ne), dissolved in seawater can be useful tracers of freshwater added by the glacier melting since the air bubbles trapped in glacial ice dissolve in seawater, resulting in supersaturation. To investigate the distributions of glacier meltwater (GMW) in the Amundsen Sea, Antarctica, we measured the two noble gases, He and Ne, in the water column of the Amundsen Sea in 2011 and 2012. The measured saturation anomalies of He and Ne (ΔHe and ΔNe) ($\Delta C = (C/C_{eq} - 1) \times 100\%$, where He_{eq} and Ne_{eq} are at equilibrium with the atmosphere) were in the range of 3 – 35% and 2 – 12% (n>80), respectively, near the Dotson– and Getz Ice Shelves (DIS and GIS). The calculated GMW fraction in seawater, based on the excess ΔHe, in DIS, GIS and Dotson trough (DT) regions, were 0.4 – 2.0%, 0.4 – 0.8%, and 0.4 – 1.2%, respectively. Along the DT, the largest GMW fractions (up to 1.2%) were observed in 400 – 500 m depth where the warm CDW melts the base of the ice shelves along DT in 2011. This large extent of GMW were even appeared nearly 300 km away from the ice shelves, suggesting that GMW can be transported more than several hundred kilometers offshore. Near the ice shelves, the GMW fraction was substantially higher in DIS than those in GIS and the largest (up to 2.0%) of GMW were observed in the western part of DIS. In 2012, the GMW fractions decreased up to 30 – 40% in DIS and GIS, respectively, indicating distinct temporal variability in glacial melting compared to 2011. Our results imply that ΔHe and ΔNe are sensitive GMW tracers with high spatio-temporal resolutions.

Keywords (max 5)
Amundsen Sea, Glacier melting, Noble Gas, Helium, Neon

OCEAN ACIDIFICATION OBSERVATION NETWORK FOR THE ARCTIC AND SUB-ARCTIC PACIFIC OCEANS

Liqi Chen

Key Lab of Global Change and Marine Atmospheric Chemistry(GCMAC), Third Institute of Oceanography(TIO), State Oceanic Administration (SOA), China

chenliqi@tio.org.cn

ABSTRACT

The ocean acidification (OA) in 21 century has obviously speeded up in comparison of since 55m years. The averaged surface pH of the world ocean has dropped down 0.1 since the industrial revolution and would be projected to decrease 0.3-0.4 pH in the end this century, equal to increasing 1-1.5 times in ocean acidity. Due to its cold water temperature and the low alkalinity as well as sea ice rapid retreating, the Arctic Ocean and subarctic Pacific Ocean(AOPO) have absorbed massive atmospheric CO_2 and changed the $CaCO_3$ system to appear large scale aragonite unsaturated state. From 1994 to 2005, the unsaturated state of aragonite was found from the continental shelf and slope to extent into the upper surface water of the Canada Basin from the south of 77°N with surface water of 0-30m to 84°N with the middle water of 75-250m,respectively. By 2010, the unsaturated aragonite state region continued to expand northward and shallower. This is the first time to observe at high latitudes as to the north of 84 °N with 50 m depth in the Canada Basin. OA in SOPO will be greatly changed in marine chemical environment to affect marine ecosystem. Therefore, it is important to develop an Ocean Acidification Observation Network for the Arctic and sub-Arctic Pacific Oceans linked with GOA-ON, AMAP-AOA etc.

SEA-AIR CO_2 FLUXES IN THE SOUTHERN OCEAN FOR THE LATE SPRING AND EARLY SUMMER IN 2009

Suqing Xu

Suqing Xu[1,2], Liqi Chen[1], Haiying Chen[3], Jonathan Li[4,5], Wuhui Lin[1,6]*

[1]he Third Institute of Oceanography, Key Laboratory of Global Change and Marine-Atmospheric Chemistry, State Oceanic Administration, Xiamen 361005, China
[2]TheSecond Institute of Oceanography, State Key Laboratory of Satellite Ocean Environment Dynamics, Hangzhou 310012, China
[3] The Third Institute of Oceanography, Laboratory of Marine Acoustics and Remote Sensing Technology, State Oceanic Administration, Xiamen 361005, China
[4] Xiamen University, MoE Key Laboratory of Underwater Acoustic Communication and Marine Information Technology, School of Information Science and Engineering, 422 Siming Road South, Xiamen 361005, China
[5] University of Waterloo, Department of Geography and Environmental Management, 200 University Ave. West, Waterloo, Ontario N2L 3G1, Canada
[6] Tsinghua University, Department of Engineering Physics, Beijing 100084, China

xusuqing@tio.org.cn

ABSTRACT

The Southern Ocean is an important sink of atmospheric carbon dioxide (CO_2) and the magnitude of the CO_2 sink is uncertain because of the scarcity of in-situ observations due to its remote and rough waters. Empirical relationships were deduced based on the in-situ pCO_2 in the surface seawater and its main controls including Chlorophyll a (Chl-a) and Sea Surface Temperature (SST) obtained during the 26th CHINARE cruise in late spring (November) and early summer (December) 2009. An extrapolation method based on multiple linear regressions was set up for combining the empirical relationship with remote sensing data to compute the sea-air carbon fluxes and carbon uptake in the Southern Ocean (south of 50°S). The empirical relationships are validated with independent measurements from the Lamont-Doherty Earth Observatory (LDEO) database. The mean standard deviation differences (Std) between extrapolated and measured pCO_2 from Global Surface pCO_2 (LDEO) database (7.69 to 26.16 ppm) is consistent with the precision of our regressions (13.6 to 21.3 ppm). Including the effects of sea ice, we estimate a CO_2 source in November 2009 of 1.65 Tg C with an uncertainty of ±1.73 Tg C in the Southern Ocean by uncertainty propagation formula. While in December 2009, we estimated a CO_2 sink of -2.34 Tg C with an uncertainty of ±1.76 Tg C in the Southern Ocean. We further estimated the carbon source and sink by separating the Southern Ocean into three ocean sectors namely the South Pacific Ocean, the South Indian Ocean and the South Atlantic Ocean. For the austral summer, the South Atlantic Ocean remained a strong carbon sink while the South Indian Ocean declined sharply from a

CO_2 sink of -0.78 Tg C in December 1999 to -0.043 Tg C in December 2009. Our results imply that from the annual declining trend, the Indian Ocean would be a carbon source in summer.

CONTRASTING CO CYCLES IN THE SURFACE MIXED LAYER BETWEEN THE NORTH PACIFIC AND THE AMUNDSEN SEA

Young Shin Kwon

Young Shin Kwon[1], Tae Siek Rhee[1], and Hyoun-woo Kang[2]*

[1]Korea Polar Research Institute, Korea
[2] Korea Institute of Ocean Science and Technology, Korea

kwonys@kopri.re.kr

ABSTRACT

Carbon monoxide (CO) plays a primary role in regulating the oxidizing power of the atmosphere. In the upper ocean, CO exhibits a strong diurnal cycle being produced by photolytic decomposition of chromophoric dissolved organic matter (CDOM), consumed by microbes, and outgassed by the gas exchange process. To investigate dominant processes that govern the budget of dissolved CO in the mixed layer, we measured air-sea CO flux and microbial consumption of CO during the two expeditions in the Amundsen Sea and the North Pacific in summer season of 2012. In the North Pacific, the sea-to-air flux density was ~2 μmol/m^2/d, slightly larger than that in the Amundsen Sea although the Amundsen Sea was more supersaturated with respect to the CO in the overlying air. Irradiation for the photolytic production was also twice more intense in the North Pacific. Dark incubation experiments conducted onboard revealed that microbial consumption rate of the CO in the mixed layer are quite different. The mean residence time against the microbial consumption in the North Pacific was about 4 hours while 60 hours in the Amundsen Sea. The surface mixed layer depth was far deeper in the Amundsen Sea than in the North Pacific. Our observation indicates that indistinct diurnal variation of dissolved CO in the Amundsen Sea likely to be due to deep mixed layer and slow microbial consumption while the shallow mixed layer and intense microbial consumption of dissolved CO in the North Pacific render diurnal variation to be stronger.

STRATEGY OF PHOTO-PROTECTION ON PHYTOPLANKTON ASSEMBLAGES IN THE KONGSFJORDEN, SVALBARD, ARCTIC

Sun-Yong Ha

Sun-Yong Ha[1], Doo Byoul Lee[1], Sung-Ho Kang[1] and Kyung-Hoon Shin[2]

[1]Korea Polar Research Institute, Incheon Korea
[2]Hanyang University, Korea

syha@kopri.re.kr

ABSTRACT

Photo-protective functions in phytoplankton assemblage were investigated UV-absorbing compounds (mycosporine-like amino acids (MAAs)), xanthophyll pigments (diadinoxanthin (DD) and diatoxanthin (DT)) and <beta>-dimethylsulphoniopropionate (<beta>-DMSP) at Kongsfjorden, Svalbard, during the Arctic springtime. Regarding the dominant phytoplankton species, the inner bay was dominated by *Phaeocystis* spp. and nanoflagellates, and the offshore waters were dominated by *Thalassiosira* spp. In the inner bay, UV-absorbing compounds and xanthophyll pigments exhibited higher ratios of MAA to chlorophyll *a* (MAA:chl *a* ratio), and DD and DT to chlorophyll *a* (DD:chl *a* ratio and DT:chl *a* ratio), respectively. Thus, the photoprotective-pigments such as DD and DT may complement MAAs in the natural phytoplankton assemblage. However, the ratio of <beta>-DMSP to chlorophyll *a* (<beta>-DMSP:chl *a* ratio) did not show a distinct spatial distribution according to environmental factors or interspecies differences. In this study, we found that photoprotective compounds are employed in a manner dependent on the phytoplankton species composition in Kongsfjorden Bay, where *Phaeocystis* is the dominant species.
This work was supported by the Korea Polar Research Institute projects (PM14040).

GROWTH AND LIPID FORMATION OF ARCTIC MICROALGAE *CHLAMYDOMONAS SP.* ARM0029C

Eun Jae Kim

Eun Jae Kim[1,2], Woongsic Jung[1], Suyoun Lim[1], Sanghee Kim[1], Han-Gu Choi[1], and Se Jong Han[1,2]*

[1]Division of Life Sciences, Korea Polar Research Institute, KIOST, Incheon 406-840, Korea
[2]Department of Polar Sciences, University of Science and Technology, Incheon 406-840, Korea
[*]Corresponding author's Tel: +82-32-760-5521, E-mail: hansj@kopri.re.kr

ABSTRACT

Microalgae can utilize sunlight and CO_2 to synthesize organic materials and store chemical energy. In winter, outdoor mass cultivation for lipid production by microalgae is hampered by poor growth. Arctic *Chlamydomonas* sp. ArM0029C has an optimal growth temperature of 4℃ and cell density was 1.4×10^7 cells/mL. Lipid body formation was visualized by BODIPY 505/515 staining and fluorescence microscopy. Fatty acid methyl ester content was determined by gas chromatography, which showed predominance of palmitic acid methyl ester, 5,8,11-heptadecatrienoic acid methyl ester, oleic acid methyl ester, linoleic acid methyl ester, and α-linolenic acid methyl ester. 5,8,11-heptadecatrienoic acid methyl ester comprised the maximum portion and the unsaturated fatty acid content was higher than that of saturated fatty acids at 8℃. *Chlamydomonas* sp. ArM0029C grows and produces fatty acids at low temperature and may represent a good source for useful lipid production in cold environments.

TAXONOMIC VARIABILITY OF PHYTOPLANKTON AND RELATIONSHIP WITH PRODUCTION OF CDOM IN THE POLYNYA OF THE AMUNDSEN SEA, ANTARCTICA

Yoon Chang Lee[1], Mi Ok Park[1], Jinyoung Jung[2], Eun Jin Yang[2], Sang Hoon Lee[2]

[1]Pukyong National University, Korea
[2]Korea Polar Research Institute, Incheon, Korea

mopark@pknu.ac.kr

ABSTRACT

We examined the taxonomic variability of phytoplankton, nutrients and chromophoric dissolved organic matter (CDOM) from two cruises ANA02C (February, 2012) and ANA04B (January, 2014), to evaluate the relationship between the phytoplankton composition and CDOM production in the Amundsen Sea. The highest concentrations of chlorophyll a (Chl-a) were found in the Amundsen Sea Polynya (ASP), during austral summer in January and February. The average concentration of Chl-a was 3.92μg L^{-1} (± 3.14μg L^{-1}) in January and 2.31μg L^{-1} (± 1.01μg L^{-1}) in February in ASP regions. The major phytoplankton groups were diatoms and prymnesiophytes and the minor groups were cryptophytes, chlorophytes, dinophytes, chrysophytes and cyanophytes. Variability in the phytoplankton composition in the sea ice zone (SIZ), ASP and ice shelf (IS) regions in the Amundsen Sea was distinct. The predominance of *Phaeocystis antarctica* (*P. antarctica*) (70–90%) was observed at all stations during austral summer in both January and February, except in SIZ regions in January. The CDOM values ranged from 0.07 to 0.98m^{-1} and were relatively high in the euphotic layer in ASP regions. The CDOM value from the euphotic layer in the ASP was 0.51m^{-1} (± 0.19m^{-1}), which was much higher than any other region of the Southern Ocean. The slope ($S_{300\text{-}500}$) values ranged from 7 to 27μm^{-1} and $S_{300\text{-}500}$ were relatively higher in ASP throughout water column. The slope shows the characteristics of young CDOM in this region. CDOM showed positive correlation with Chl-a and no clear relationship with salinity, which implies that biological processes were the main source of CDOM in the study area. CDOM can be affect the function of the biological pump by phytoplankton in the Southern Ocean. We showed the significantly correlation between CDOM and Chl-a (hex-fuco) in the ASP, which suggest that main source of CDOM was *in-situ* production of biological origin during austral summer. Since little increased of CDOM in the seawater, when ice coverage decreased by early open polynya, can contribute significant total absorption of UV-Vis radiation, it would be very important not only for phytoplankton groups but also sea surface temperature (SSTs) increase and subsequent possible photo-oxidation of CDOM to give CO_2.

Keywords : Chl-a, CDOM, slope, diatoms, *Phaeocystis*, polynya, the Amundsen Sea.

DIEL VERTICAL MIGRATION OF ARCTIC COPEPODS UNDER SEA ICE IN THE CANADA BASIN

Hyoung Sul La[1], Koji Shimada[2], Eun Jin Yang[1], Sun-Yong Ha[1], Eri Yoshizawa[2], Jun-Oh Min[1], Sung-Ho Kang[1], Ho Kyung Ha[3]*

[1] Korea Polar Research Institute, Incheon, South Korea
[2] Tokyo University of Marine Science and Technology, Tokyo, Japan
[3]Department of Ocean Sciences, Inha University, Incheon, South Korea

hsla@kopri.re.kr

ABSTRACT

The vertical migration of zooplankton is essential component of the 'biological pump in the Arctic as they actively export carbon out of the productive surface waters to the bottom. Arctic copepods of the genus *Calanus*, which are the dominant herbivores in Arctic seas, play a key role in pelagic food webs. We investigated the vertical migration of Arctic copepods under sea ice during summer using a 300-kHz acoustic Doppler current profiler (ADCP). Three sediment traps were moored at 15-m depth from under sea ice to verify the zooplankton species. These were supplemented by environmental data collected with a conductivity, temperature and depth (CTD) profiler. The *Calanus hyperboreus* was predominant with about 5 mm total lengths. The acoustic backscatter showed a typical diel vertical behavior with a significant correlation with surface solar radiation, even if the region was covered by sea ice. This study could provide important information what factors determine the migration behavior of *Calanus hyperboreus* under Arctic sea ice during summer.

PENGUIN COUNTING USING UAV IMAGING AND OBJECT BASED IMAGE ANALYSIS

Chang-Uk Hyun, Hyun-cheol Kim, Jeong-Hoon Kim, Soon Gyu Hong*

Korea Polar Research Institute, Incheon Korea

kimhc@kopri.re.kr

ABSTRACT

Remote sensing technique has been applied to monitoring wildlife that enables estimation of population size and identification of habitat distribution. The area around Narębski Point located on the southeast coast of Barton Peninsula, King George Island, Antarctica was designated as Antarctic Specially Protected Area No. 171 (ASPA 171), and Chinstrap and Gentoo pengins inhabit in the area. It is important to fulfill periodic, precise monitoring because variations of their populations are able to reflect environmental changes and disturbance from human activities. In this research, population of penguins was counted in a part of Barton Peninsula using images obtained from unmanned aerial vehicle (UAV) and object based image analysis (OBIA). About 1,500 images acquired in January 2014 were mosaicked as an image of about 3 cm spatial resolution and then a subset including representative penguin rookery was selected. The UAV image was segmented based on gradient map of pixel values, and spectral and spatial attributes were assigned to each segment. The OBIA method considered spectral attributes including mean and minimum values of each segment and various spatial attributes such as area, length, compactness and roundness. The segments indicating individual penguins were effectively detected on rookeries with high contrasts in the attributes. It is expected that this method can be applied to other penguin habitats in Antarctica and the results can support establishing effective environmental management plans.

OCCURRENCE OF VARIOUS INGREDIENTS IN THE AQUATIC ENVIRONMENTS OF TWO LAKES AT STORNES PENINSULA, LARSEMANN HILLS, EAST ANTARCTICA

Pawan Kumar Bharti[1], Enn Kaup[2], Bhupesh Sharma[1] and U.K. Niyogi[1]*

[1]Antarctica Laboratory, R & D Division,
Shriram Institute for Industrial Research, 19, University Road, Delhi-110 007, India
[2]Department of Isotope Paleo-climatology, Institute of Geology, Tallinn University of Technology, Tallinn, Estonia

gurupawanbharti@gmail.com
Tel.: +91 11 27667267, Fax: +91 11 27667676

ABSTRACT

The Larsemann Hills is an ice-free area of approximately 50 km^2, located halfway between the Vestfold Hills and the Amery Ice Shelf on the south-eastern coast of Prydz Bay, Princess Elizabeth Land, East Antarctica (69°30'S, 76°19'58"E). The area consists of two major peninsulas Stornes and Broknes, four minor peninsulas, and approximately 130 near shore islands. There are more than 150 lakes on different peninsulas and islands.

Surface water samples were collected from two lakes on Stornes Peninsula during 30th Indian Scientific Expedition to Antarctica (ISEA) in mid-January 2011 and analysed for the physico-chemical parameters, major elements and trace metals. Lake waters were slightly acid, free from any colour, odour and turbidity, with dissolved oxygen close to saturation. Total dissolved solids were rather similar in both lakes, up to 71 mg/l and the dominant elements were Cl and Ca. Several minor and trace elements were very low or under detection limits. Total organic carbon was ca 0.7 mg C/l in both lakes and PO_4 was at 0.002 mg/level in one lake. Several pesticide residues were all under detection limits as well as alpha and beta radiation activities. Total bacterial count was 1.6×10^3 cfu/ml in lake ST-2 and lower in other lake while psychrophilic bacterial count was 1.6×10^2 cfu in the former lake. Also a Pseudomonas spp. was detected in the ST-2 lake sample.

Key words: Water quality monitoring, Antarctic lakes, Larsemann Hills, water pollution

TEMPORAL VARIATION OF TROPOSPHERIC OZONE AND SPRINGTIME OZONE DEPLETION EVENTS AT KING SEJONG STATION, ANTARCTICA

Sora Seo

Sora Seo[1], Tae Siek Rhee[1], Keyhong Park[1] and Sang-Jong Park[1]*

[1]Korea Polar Research Institute, Korea

westsora@kopri.re.kr

ABSTRACT

Tropospheric ozone concentration and meteorological factors were measured from 2009 to 2013 at King Sejong station (KSG) located at the tip of the Antarctic peninsula, King George Island. The trend estimation of ozone for each month did not show any significant increasing or decreasing trends during the study period. However, tropospheric ozone concentration showed seasonal variation of 14~34 ppbv with high and low concentration in winter and summer, respectively. Ozone depletion events (ODEs), which are natural phenomena that background ozone rapidly drops near zero level, were frequently found during the austral spring from August to November. The monthly mean depleted ozone concentration due to ODEs was 0.7~2.1 ppbv, which can affect the polar chemical processes, radiation budgets, and further climate. In addition to the seasonal variation, diurnal variation of ozone derived from the solar radiation was found with the range of 0.4~0.8 ppbv, although this change is small compared to other non-polar regions due to low NOx concentration. For simple calculation of tropospheric ozone budget in high latitude region of Southern Hemisphere based on ozone data at KSG, a conceptual box model was developed. This model showed that the net loss term including photochemical destruction and deposition is balanced with the net gain term of stratospheric entrainment. Also, we found that ODEs at KSG are significantly related with not only specific meteorological conditions including lower temperature, higher wind speed, and easterly wind but also air masses advected from the Weddell Sea covered by the extended sea-ice through the backward trajectory analysis.

LONG-TERM VARIABILITY OBSERVATION OF ALBEDO AND ITS RELATIONSHIP WITH SURFACE TEMPERATURE OVER ANTARCTICA

Minji Seo

Minji Seo[1], Kyung-Soo Han [1], Changsuk Lee[1], Hyunji Kim[1], Kyeong-sang Lee[1], Nohun Seong[1], Sungwon Choi[1] and Hyun-cheol Kim[2]*

[1] Department of Spatial information Engineering, Pukyong National University
[2]Korea Polar Research Institute, Incheon, Korea

kyung-soo.han@pknu.ac.kr

ABSTRACT

Albedo of the polar regions is an essential part for understanding the climate change as well as the temporal and spatial changes of climatic parameters such as temperature and Antarctic Oscillation. In previous studies, albedo is one of important variables with regard to the radiation budget. Due to these features, Albedo variability plays an important role of an indicator in Antarctica which mainly is covered with snow and ice. In this research, we analyzed the long-term temporal and spatial variability of albedo and investigate the interrelationship between albedo and temperature over Antarctica. We used surface albedo data provided by Satellite Application Facility on Climate Monitoring (CM SAF) and temperature data from the Reference Antarctic Data for Environmental Research (READER) during 1983 to 2009. We performed a simple linear regression analysis and harmonic analysis in order to understand the temporal trend of albedo. The results indicate two implications: the results shows different albedo trends between the East and West. East Antarctica has positive trend and West Antarctica has negative trend of albedo. Another indication we found from the results was that the albedo has a long-term cycle. In addition, we examined a relation of albedo and temperature. The correlation between albedo and temperature has a range of -0.7 to -0.3.

POSTER SESSION

Arctic, Biology and Other Related

ROLE OF BACTERIA IN MOBILIZATION OF MAJOR AND TRACE ELEMENTS IN POLAR ROCKY SOILS UNDER CONDITION OF CLIMATE WARMING

Kai Künnis-Beres

Kai Künnis-Beres[1] and Enn Kaup[2]*
[1]Institute of Marine Systems, Tallinn University of Technology, Tallinn Estonia
[2]Institute of Geology, Tallinn University of Technology, Tallinn, Estonia

kkunnis@gmail,com

ABSTRACT

Polar lakes as ecosystems appear to respond rapidly to climate change. Therefore the catchments of simply structured and delicate polar lakes offer ideal systems to study the impact of climate warming as many of them balance at the melting point of ice during summer. The aim of our study was to clarify the role of indigenous bacterial community in weathering of rocks and minerals, and how these processes can change in conditions of rising temperature and increasing load of nutrients. The rock/soil samples were collected from the catchment of Lake Saanajärvi in Kilpisjärvi (NW Finland) and from central part of Schirmacher Oasis (East Antarctica). In Saana Lake catchment the sampling depth was 28-33 cm from the soil surface. From Schirmacher Oasis two depths were sampled, 1-6 cm and 20-28 cm from the soil surface. The leaching of 29 major and trace elements were investigated in aerobic and anaerobic conditions at different temperatures (4, 12 and 20 ℃) and concentrations of nutrients.
The aerobic release of elements was the highest for Al, K, Mg, Mn, Na and Fe from granite incubated with bacteria isolated from the same granite surface (Kilpisjärvi). Anaerobic conditions and nutrients addition supported remarkably the leaching of Fe, Mg and Sr, but not the leaching of Mn. From trace elements only the release of Ru was accelerated in presence of bacteria.
From mineral soil samples of Schirmacher Oasis the release of soluble elements into leachate was bigger and the temperature sensitivity of the local bacterial communities were higher in the deeper (20 - 28 cm) soil sample if compared the same parameters of the near surface soil samples (1 - 6 cm). The addition of bioavailable nitrogen and phosphorus in concentrations typical for Antarctic regions with moderate human impact (1.5 mg N/L; 0.03 mg P/L) increased the bacterial activity which accelerated the release of Al, K, Co, Fe, V, Ti from the deeper soil samples (20 - 28 cm). The rise of temperature, from 4 to 12 °C, increased the number of cultivable bacteria only in "natural" test conditions.
The results suggest that under condition of increased temperatuure and available nutrients, the combined heterotrophic and chemolitotrophic bacterial activety in the catchments can contribute to the increase in soluble major and trace elements in polar lakes water. The increased mobilization of nutrients and inorganic elements will change significantly the polar lakes chemistry, productivity and ecological status.

SOIL ORGANIC MATTER, BACTERIAL COMMUNITY STRUCTURE AND SOIL PROPERTIES OF A MOIST ACIDIC TUSSOCK TUNDRA IN COUNCIL, ALASKA

Yoo Kyung Lee

Sungjin Nam[1], Hyemin Kim[2], Ji Young Jung[1] and Yoo Kyung Lee[1]*

[1]Korea Polar Research Institute, KIOST, Incheon Korea
[2]Seoul National University, Incheon Korea

yklee@kopri.re.kr

ABSTRACT

Soil is the largest carbon reservoir in the terrestrial ecosystem, and thus small changes in soil carbon could greatly affect the carbon balance in the ecosystem. Particularly, the arctic permafrost has been gained a lot of attention recently with regard to climate change because the large amount of soil organic matter (SOM) is stored in this region. Moreover, many studies have shown that the SOM stored in permafrost are very vulnerable to climate change. The climate-sensitive SOM could have a strong positive feedback to climate. Therefore, it is essential to reveal the characteristics of SOM in the arctic environment to understand the fate of SOM. In Council, Alaska, we are characterizing SOM and microbial community structure in moist acidic tussock tundra. We collected upper 0-10 and 10-20 cm depth of soil from 36 sampling points over the area of about 300 × 50 m. The characteristics of SOM and microbial community structure were analyzed by pyrolysis-gas chromatography (py-GC/MS) and pyrosequencing of 16S rRNA genes, respectively. The preliminary results of py-GC/MS showed that the upper and lower layer soils were distinguished and the upper layer soil was more related to polysaccharides and N compounds. Microbial community structure was also different between two layers, and *Alphaproteobacteria* decreased with soil depth. The relationship between the characteristics of SOM and soil physical, chemical parameters and bacterial community structure is currently undertaken.

This study was supported by National Research Foundation of Korea (NRF-2011-0021063, NRF-2011-0021067) (PN14082, KOPRI).

DOMIBACILLUS TUNDRAE SP. NOV., ISOLATED FROM ACTIVE LAYER SOIL OF TUSSOCK TUNDRA IN COUNCIL, ALASKA

Yoo Kyung Lee

Hye Ryeon Gyeong, *Kiwoon Baek, Chung Yeon Hwang, Ki Heon Park, Hye Min Kim, HongKum Lee and Yoo Kyung Lee*

Korea Polar Research Institute, Republic of Korea

yklee@kopri.re.kr

ABSTRACT

A novel Gram-positive, spore-forming, aerobic, motile and rod-shaped bacterium designated as strain PAMC 80007^T was isolated from active layer soil sample of moist acidic tundra in Council, Alaska. Optimal growth of strain PAMC 80007^T was observed at 30 ℃, pH 7.0 and in the presence of 2 % (w/v) NaCl. Phylogenetic analysis based on 16S rRNA gene sequence indicated that strain PAMC 80007^T belonged to the genus *Domibacillus*. This strain was closely related to *Domibacillus enclensis* (98.3 %), *D. robiginosus* (98.3 %) and *D. indicus* (97.2 %). Genomic DNA G+C content was 43.5 mol % and genomic relatedness analyses based on the average nucleotide identity and the genome-to-genome distance showed that strain PAMC 80007^T is clearly distinguished from the closely related *Domibacillus* species. The major fatty acids (>5 %) were iso-C15:0 (24.7 %), C16:1 ω11c (16.8 %), anteiso-C15:0 (16.5 %), C16:0 (15.6 %) and anteiso-C17:0 (8.7 %). The major respiratory isoprenoid quinines were menaquinone-6 (MK-6) and menaquinone-7 (MK-7), and the polar lipid profile contained diphosphatidylglycerol (DPG), phosphatidylglycerol (PG), phosphoglycolipid (PGL), phospholipid (PL) and two unidentified lipids (L1, L2). The major whole-cell sugar was ribose with minor quantity of glucose and meso-diaminopimelic acid (type A1γ) was present in the cell-wall peptidoglycan. Results from polyphasic study suggested that strain PAMC80007^T is a novel species of the genus *Domibacillus* for which the name *Domibacillus tundrae* sp. nov. is proposed. The type strain is PAMC 80007^T (= JCM 30371^T = KCTC 33549^T = DSM 29572^T).

ISOLATION AND IDENTIFICATION OF ANAEROBIC BACTERIA FROM ARCTIC TUNDRA SOILS

Yoo Kyung Lee

Ki Heon Park, Hye Ryeon Gyeong, Hye Min Kim, Hong Kum Lee, and Yoo Kyung Lee*

Korea Polar Research Institute, Korea

yklee@kopri.re.kr

ABSTRACT

The Korea Polar Research Institute (KOPRI) has operated the Polar and Alpine Microbial Collection (PAMC) since 2012. Although, PAMC holds approximately 7,000 strains of bacteria, not many of the strains were isolated from anaerobic conditions. The soil samples were collected from a total of 36 sampling sites in tussock tundra of Council, Alaska. The soil samples were stocked in 15% glycerol, and transported to the KOPRI under frozen and anaerobic conditions. The inoculation of bacteria was performed in the anaerobic chamber, using TSA, R2A and ISP4 as isolation media. The culturing temperature was 20℃. After sub-culturing, the isolated strains were stocked in 40% liquid glycerol and stored at -80℃. The revival test was performed on the anaerobic bacteria that had been stocked for 2 ~ 3 months. The strains that had passed the revival test were stored in PAMC. A total of 209 strains have been isolated, among them, 127 strains have been identified on the basis of 16S rRNA genes. They belonged to 14 genus and 27 species, with more than half being *Paenibacillus*. Most of the strains were facultative anaerobic strains with one exception of an obligate anaerobe *Clostridium algidixylanoyticum*. The revival test and identification of the remaining strains are still underway, also taxonomic studies to find candidate strains for new species are ongoing.

TRANSCRIPTOME ANALYSIS AND DISCOVERY OF INDUCED IMMUNE RESPONSE GENES BY PATHOGEN AGONIST IN THE ANTARCTIC BULLHEAD NOTOTHEN *NOTOTHENIA CORIICEPS*

Do-Hwan Ahn

Do-Hwan Ahn[1,2], Seunghyun Kang[1], Mi-Kyeong Kim[1], Hyoungseok Lee[1], Jungeun Lee[1] and Hyun Park[1,2]*

[1]Korea Polar Research Institute, Korea
[2]University of Science & Technology (UST), Daejeon, Korea

hpark@kopri.re.kr

ABSTRACT

The Antarctic sea have a distinguishing marine environment with the coldest ocean and isolated water flow. The temperature of large portions of the Antarctic sea is less than 0 ℃, and the water flow of Antarctic sea is thermally stable throughout the year. So, there are small alteration for Antarctic organism. Notothenia coriiceps, a typical Antarctic notothenioid teleost, has evolved to adapt to the cold and stable Antarctic marine environment for millions of years. Thus, they are considered an attractive model species for immunological studies and prediction of ancient immune signal pathways. We previously reported an extensive analysis of the Antarctic notothenioid transcriptome. In this study, we focused on signal pathways and immune response against bacterial / viral pathogenic stimulation in liver tissues. We performed RNA-seq in liver tissues challenged two pathogen-mimicking agonists [heat-killed E. coli and poly (I:C)]. RNA-seq was conducted to generate expressed short reads by Illumina MiSeq system. Approximately 57.12 million Illumina PE raw reads were generated. After removing adaptor sequences and trimming low-quality sequences, clean reads were annotated to perform enrichment test with 32,286 unigenes of established notothenioid transcriptome. Using Kyoto Encyclopedia of Genes and Genomes (KEGG) database / KEGG Automatic Annotation Server (KAAS), 261 unigenes were assigned to immune response related group, including Toll-like receptor, Tumor necrosis factor and Antigen processing. We selected total 215 functional features for signal pathway analysis. A subset of the immune response genes that related Antigen processing signal pathway were expressed at higher levels in fish exposed to heat-killed E. coli, but not poly (I:C). Further research is required to elucidate different immune response by type of pathogens.

A STUDY TO SELECT THE DIAGNOSTIC MORPHOLOGICAL CHARACTERS TO IDENTIFY THE SPECIES IN THE *CLADONIA GRACILIS* GROUP

Jae Eun So[a,b], Ji Hee Kim [a], Soon Gyu Hong [a,b]

[1]Division of Polar Life Sciences, Korea Polar Research Institute, Incheon 406-840, Republic of Korea,
[2]Department of Polar Sciences, University of Science and Technology, Incheon 406-840, Republic of Korea

cladonia@korpi.re.kr

ABSTRACT

The genus *Cladonia* usually lives on soil, moss and dead tree, and more than 400 species hitherto have been documented. It reported from the wide range of habitats, including some of the most extreme conditions on the earth. The genus has a high morphological diversity, and the delimitation of many species has been remained unclear as well. Of them, the *Cladonia gracilis* complex and the allies in the section *Cladonia* shows an extreme phenotypic variety. The previous study, about 23 species are included in this group and provisionally call them as subgroup "*Graciles*". Because the species in the subgroup "*Graciles*" are morphologically similar to each other, and each species has a high intraspecific variation, they are considered as a quite difficult group to identify until the species level. The combination of several charateristics and geographical distribution has been used as criteria for identification. Nevertheless, the clear identification among the group has still remained as a difficult problem. In order to select diagnostic characters of *Cladonia gracilis* group, the related traditional characters evaluated with molecular phylogenetic analysis in this study.

PREPROCESSING MAKE CRITICAL BIAS AT MICROBIAL COMMUNITY

Kyuin Hwang, Soon Gyu Hong

Korea Polar Research Institute, Korea

ABSTRACT

Next-generation sequencing technology (NGS) is becoming a standard method to examine microbial diversity of environmental and human microbiome samples. Read number is used to estimate relative abundance of specific taxa in the samples as a key parameter to define microbial community structures. However, read number is affected not only by relative abundance of the taxa in the original sample but also by various processes such as PCR amplification, sequencing reactions and sequence processing pipelines including trimming, filtering, noise removing, chimera detection, clustering, and DB search. Although sequence read number biases by PCR and sequencing reactions are well known, read number bias created by quality trimming and filtering is hardly known. Trimming low-quality nucleotides and filtering out short sequence reads are included in most of the popular NGS processing pipelines to analyze microbial community based on only high-quality sequence reads. These processes are based on the assumption that low-quality reads are evenly distributed among taxa. However, we found that sequence quality is highly dependent on the sequence context, which in turn can create biased sequence trimming and discarding sequences from specific taxa. Therefore, we propose that sequence quality trimming and filtering should be conducted with more lenient trimming options or trimming read at the last high-quality region instead of trimming at the first low-quality region/base to mitigate read number bias.

STRUCTURAL AND BINDING PROPERTIES OF TWO FATTY ACID-BINDING PROTEINS FROM GENTOO PENGUIN

Changwoo Lee

Chang Woo Lee[1,2], Hackwon Do[1], and Jun Hyuck Lee[1,2]*

[1]Division of Polar Life Sciences, Korea Polar Research Institute, Incheon 406-840, Republic of Korea
[2]Department of Polar Sciences, University of Science and Technology, Incheon 406-840, Republic of Korea

justay@kopri.re.kr

ABSTRACT

Fatty acid binding proteins (FABP) are small (approximately 15 kDa) widely expressed intracellular proteins that assist in the intracellular transport of fatty acid and other lipophilic molecules. Isoforms of FABP have been identified in various tissues, such as liver, intestine, muscle, heart and epidermal tissues. Isoforms of FABP's primary sequence is diverse, but the structure of FABPs referred to canonical β-barrel is conserved. We crystallized pFABP4 and pFABP5 and linoleic acid bound pFABP4 from Gentoo Penguin (*Pygoscelis papus*) at 1.96, 1.9 and 2.0 resolution, respectively. Ligand binding test using 8-anilinonaphthalene-1-sulfonic acid (ANS) show that pFABP4 has relatively high affinity for linoleic acid compared with pFABP5. A comparison of the crystal structures shows that Leu78 of pFABP5 makes steric clash and disturb a binding of linoleic acid. Conclusively, our high-resolution structures and ligand-binding studies provide useful insights into an explanation for the ligand binding preferences of pFABPs based on key protein-ligand interactions.

ASSOCIATED MEETINGS

PERMAFROST SESSION

VARIABILITY OF SUMMERTIME SURFACE ENERGY COMPONENTS AT AN ALASKA TUNDRA SITE

Sang-Jong PARK

Sang-Jong PARK[1], Namyi CHAE[2], Jaeil YOO[1], Bang-Yong LEE[1], and Yongwon KIM[3]*

[1]Korea Polar Research Institute, Korea
[2]Yonsei University, Incheon Korea
[3]International Arctic Research Center, University of Alaska, Fairbanks, AK USA

sangjong@kopri.re.kr

ABSTRACT

Permafrost thawing and consequent environmental changes are gathering attention as the Arctic amplification is in progress. Multi-disciplinary research team consisting of Korea Polar Research Institute (KOPRI) and universities has carried out field work at terrestrial circum-Arctic regions. Council site on the Seward Peninsula of Alaska is characterized as tussock tundra and corresponds to tree line making the site ideal to monitor long-term environmental change. In this talk, surface energy components like net radiation, sensible heat, latent heat fluxes observed during summertime from 2012-2014 will be presented. Characteristics of diurnal and intra-seasonal variations and relations with controlling factors will be discussed.

ARCTIC PERMAFROST SEASONAL THAWING DYNAMICS (OBSERVATION AND MODELING APPROACH)

P.V. Bogorodskii

P.V. Bogorodskii, A.P. Makshtas,V.Yu. Kustov*

Arctic and Antarctic Research Institute, St.Petersburg, Russia

bogorodskii@aari.ru

ABSTRACT

Arctic ecosystems where the mean annual ground surface temperature is around or below 0℃ are very sensitive to climate change. It is especially because the Arctic regions contain vast areas of permafrost, beginning to thaw when the temperature exceeds freezing point. The data of the analysis of the soil upper layer temperature profiles, measured during last five years in the three sites near Tiksi (northern West Siberia), one of the oldest Russian Polar Stations, combining with the results of numerical modeling of the long-term response of permafrost to climate change are presented. An analytical approach was used for calculation of active layer thickness (ALT) and mean annual temperature of active layer bottom. The variability of air temperature and snow cover, as well as thermophysical properties of vegetation and soil in thawed and frozen state were taken into account. Measurements, executed in different parts of tundra, show similar spatial and temporal features of ALT and soil thermal structure, as well as their relative stability. At the same time the ALT parabolic approximation, based on the results of model calculations with parameterization of long-term evolution of vegetation, demonstrates gradual decrease of ALT from middle 1930s to middle 1970s (about 0.4 m) and subsequent increase to the value in 2014, similar to that of 1930s. Temporal variations of mean annual temperature at the bottom of the active layer show the similar character with decrease and increase up to 2 and 2.5℃, respectively. Thus the conclusions on the fast degradation of permafrost in Arctic seems to be premature. For further model calculations it needs to take into account the impact of climate change on the type and thermal properties of vegetation and heat and mass transfer properties of the soil.

TERRESTRIAL PALEOENVIRONMENTAL AND PERMAFROST STUDYING IN THE RUSSIAN ARCTIC

Makarov Aleksandr, Bolshiyanov Dmitry, Verkulich Sergey

Arctic and Antarctic Research Institute, St.Petersburg, Russia

bogorodskii@aari.ru

ABSTRACT

Arctic and Antarctic research institute (AARI) conducts research in the Arctic for the glaciology, paleogeography, including evolution of the last glacial maximum and sea-level changing during late pleistocene and Holocene, hydrology, palinolgy, quaternary geology and geomorphology, permafrost studying, isotopic investigation of the subsurface ice, soil studying, carbon cycle etc. This thesis show main results of the AARI Polar geography department studying in the Russian Arctic during last 15 years.

Sea-level changing studying.

Basing on dating analysis of the terraces of Russian Arctic coasts and mouths of main rivers, the researchers created the Sea level fluctuation curves during Holocene. The analysis included geomorphologic and geologic structure as well as traditional scheme of formation of islands in the delta. At the current stage of research it is only possible to make rough distinguish of delta development phases and receiving reservoir (Fig.1-2). The level of sea rose 200-400 years ago; 700-2000 years ago; 1-3 thousand years ago; 3.5-4 thousand years ago; 4.7-5.5 thousand years ago and about 7-8 thousand years ago. These stages are divided by shorter phases of cuttings corresponding with the drop of level of receiving reservoir.

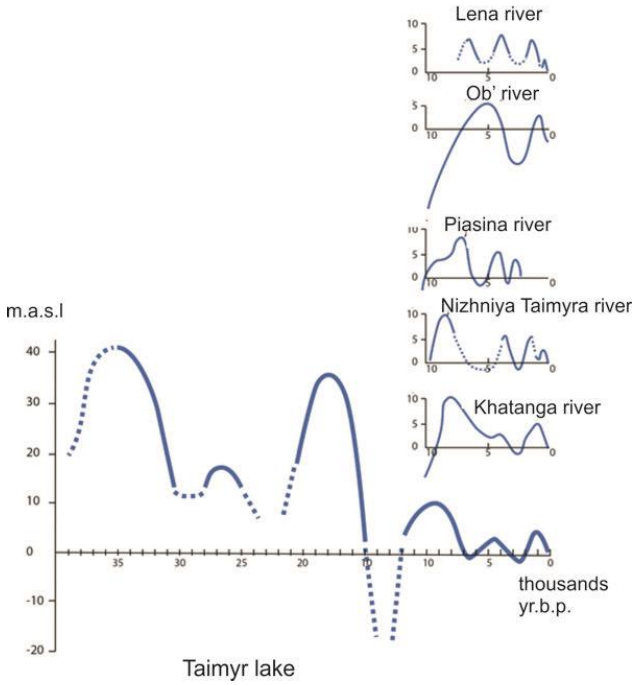

Fig. 1.Curves of the level changes of lake Taimyr and sea basins in the mouths of arctic revers.

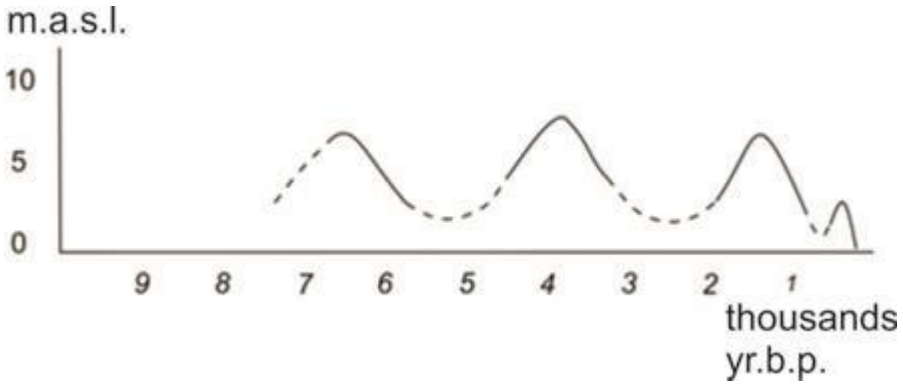

Fig..2. laptev-sea level changing during the Holocene

Paleoclimate variations during last centuries and millennium

Investigations of Russian Arctic and Antarctic lake deposits show that climate changes of last millenium and in Holocene were not synchronous both in Arctic and in Antarctic. For example climatic optimum of Holocene took place from 10 to 4 thousand years ago in different parts of Circumpolar Arctic and 4000-2000 years ago in Antarctic. Little Ice Age started in Russian Arctic from 530 to 240 years ago and finished 140-70 years ago according to results of lake sediments investigations.

Knowledge of the changes of climate of the last millennium presents a necessary key for understanding current climatic processes and predicting climate of the future. One of the methods for increasing the length of the series of climatic parameters is to investigate bottom sediments of the Arctic lakes storing rich information on environmental changes in the past. The available data on sedimentation in the sub-glacial Arctic lakes suggest that varved sediments of sub-glacial and deep tectonic lakes are deposited in direct correspondence with the climate changes occurring in the basins of lakes and primarily in accordance with the summer air temperature.

The boundaries of cooling in the last millennium – the Little Ice Age were determined (Fig. 3). The end of the LIA in the study areas was in the 1860-1930s, and the beginning - from 1480. The time of the beginning and end of the Little Ice Age differ significantly in different Arctic regions. In addition, at the time of the LIA, a warming phase is identified with duration of 20 to 100 years. Longer cores of

bottom sediments indicate that the periods of warming in the past also alternated with the periods of cooling. In the last 140-70 years, data of all cores examined indicate a warming event. Due to its manifestation before the technogenic era and the presence of cyclic cooling and warming events in the earlier time intervals of the last millennium, it can be concluded that the last warming event has a natural character and will be again replaced by cooling in the near future. The obtained results allowed us to reveal the time frames of the LIA in the central Russian Arctic. These data are necessary for investigations related to predicting future climate.

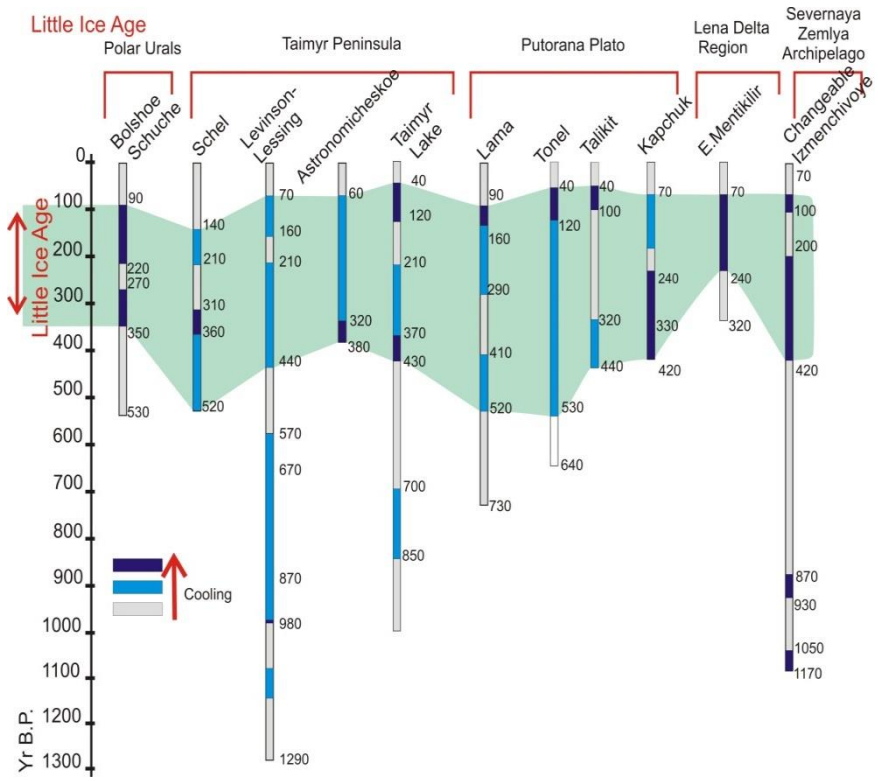

Fig.3. Little Ice Age in the Russian Arctic, according the short lake-cores studying

Glaciology investigation

The studying of climate change in the Arctic during the Holocene allowed to divide the Arctic into 14 sectors on the basis of temperature variability over the last 10,000 years fig. 4. Each of these sectors is characterized by a unidirectional nature of the development environment in the Holocene.

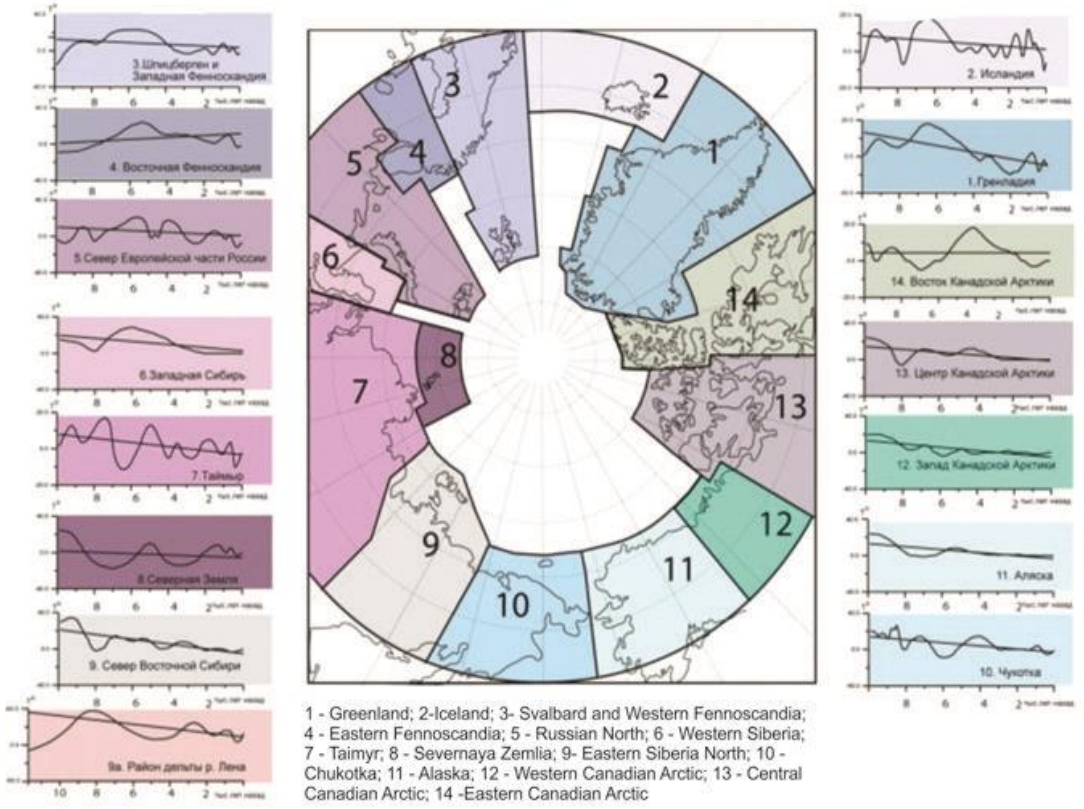

Fig. 4. Summer air temperature fluctuations in different sectors of the Arctic.

The results of 35 years of work in the Arctic makes possibility to formulate an alternative vision of glaciation during the last glacial maximum. The idea is that there is not a large ice sheet that covers the majority of the Polar Ocean. Glaciation was represented by a large number of small passive glaciers distributed throughout the Hole Arctic and which analogues are observed today on Severnaya Zemmlya Archipelago.

KOPRI RESEARCH ACTIVITIES IN ARTIC SOIL ORGANIC MATTER

Yoo Kyung Lee

Ji Young Jung[*1], *Sung Jin Nam*[1], *Se-eun Kim*[1], *Mincheol Kim*[1], *Juyoung Seo*[2], *Hojeong Kang*[2], *Anders Michelsen*[3], *Yoo Kyung Lee*[1*]

[1] *Korea Polar Research Institute, KIOST;* [2] *Yonsei University;* [3] *University of Copenhagen*

yklee@kopri.re.kr

ABSTRACT

Soil is the largest reservoir of carbon (C) in the terrestrial ecosystem, and particularly it is estimated that permafrost soil contains 1672 Pg of organic C. Arctic is one of the most sensitive ecosystems to climate change, however, it is projected that the degree of temperature increases would be more pronounced in the Arctic than further south. Climate change would lead to changes in plants (species, productivity, phenology, etc.), abiotic parameters (soil temperature, moisture content, etc.), and several processes in soil, which influence the quantity and/or quality of soil organic matter (SOM). Based on this hypothesis, KOPRI is conducting two climate manipulation experiments in Cambridge Bay, Canada and Zackenberg, Greenland. In Cambridge Bay, open top chambers are used for soil warming during the growing season, and distilled water is added to mimic increased precipitation since 2012. After one and half year manipulation, both warming and precipitation treatment increased phenol oxidase activity. The isotopic study showed that warming induced the drought stress in vegetation. In Zackenberg, Greenland, warming experiment has been conducted by small greenhouses with 50 cm diameter opening in the top since 2004. We collected soil samples under *Cassiope tetragona* and *Salix arctica* in 2011 and 2012, respectively. Soil temperature in the warming treatment was 0.9 and 0.3 ℃ higher than that in control in *Cassiope* and *Salix* plots, respectively. Most physical and chemical properties in soil were not significantly different among treatments despite a fairly long period of climate manipulation. Although soil organic carbon (SOC) and total nitrogen (TN) contents were not different among treatments, the amount of LF was lower in the warming treatment than that in control in *Cassiope* plots. ^{13}C NMR analysis showed that the ratios of the alkyl C (recalcitrant) group was relatively higher in the warming treatment than that in the control in *Cassiope* plots. Warming did not alter the amount of SOC, however, it could cause the change in SOC quality by increasing a recalcitrant portion of SOC. This study was supported by National Research Foundation of Korea (NRF-2011-0021063, NRF-2011-0021067) (PN14082, KOPRI).

MICROBIAL DYNAMICS OF A THAWING PALSA MIRE: AN INDICATOR SPECIES AND ECOSYSTEM

Rhiannon Mondav

Rhiannon Mondav[1], Carmody McCalley[2], Suzanne Hodgkins[3], Scott Saleska[4], Jeff Chanton[3] and Patrick Crill[5].*

[1]Uppsala University, Uppsala, Sweden
[2]University of New Hampshire, USA
[3] Florida State University, USA
[4] University of Arizona, USA
[5] Stockholm University, Sweden

rhiannon.mondav@ebc.uu.se

ABSTRACT

Microbial assemblages in the active layer of thawing permafrost were investigated over two years across a spatially related thaw gradient. In situ measurements of geochemical parameters enabled linkage of the community dynamics to significant shifts in C (carbon) balance and community structure. The study investigated communities from a palsa mire with three internal sites selected that were representative of distinct stages of permafrost degradation. The pristine stage of permafrost was represented by the raised section of a palsa, the end stage of thaw was represented by a 'fen' with open water and graminoid vegetation sunken several meters below the palsa in which no permafrost exists. The intermediate thawing stage, 'bog', was an actively subsiding region with a perched water table covered by a sphagnum lawn. The microbial community membership of each site was distinct with few shared species. Microbial assemblage structure in the palsa and fen samples had high richness and evenness supporting ecological theories of climax communities. The palsa site had typical soil and permafrost microbes being dominated by Acidobacteria and Proteobacteria. Microbial assemblages within the bog lost richness and diversity with depth, similar to ecosystems undergoing disturbance. Archaea, especially methanogens, dominated the bog and fen being most abundant at the water-table. C isotope signatures in porewater and CH_4 flux supported a shift from putative hydrogenotrophic methanogens in the bog to mostly acetotrophs in the fen. The discovery of a novel methanogen of the RCII archaeal lineage at up to 70% relative abundance of the community allowed recovery of a population genome. The environmentally recovered genome and proteome of this archaea, *Candidatus* Methanoflorens stordalenmirensis, indicates that methane production is its main energy conservation pathway. Meta-analysis of community surveys, 16S rRNA and mcrA genes, suggested that 'Methanoflorens spp.' are dominant and ubiquitous methanogens in permafrost and peatland soils and appears a major contributor to global methane production. This lineage had until recently only been identified as significant in temperate peatlands and was thought to be a negligible contributor to methanogenesis at high latitudes.

'Methanoflorens spp.' dominance may therefore be an indicator of circumpolar warming and thawing of permafrost. Our results revealed a distinct difference in the microbial community structure and membership at each site, which can be directly associated with increasing methane emission and thaw state.

FROM THE POINT TO THE SURFACE: HOW BAYESIAN PROBABILITIES ARE USE TO SPATIALIZE SOIL ORGANIC CARBON

Dominique Laffly

Dominique Laffly[*1], *Myrtille Moreau*[1], *Yannick le Niri*[2], *Lennart Nilsen*[2], *Ji Young Jung*[3], *Se-eun Kim*[3], *Hyeyoung Kwon*[3], *Yoo Kyung Lee1*[3]

[1] *University of Toulouse, Toulouse, France*
[2] *EISTI, Pau, France*
[3] *University of Tromsø, Tromsø, Norway*
[3] *Korea Polar Research Institute, Incheon Korea*

dominique.laffly@gmail.com

ABSTRACT

Soil Organic Carbon (SOC) are related geosystem that characterizes them. Geographical environment is defined by large zonal trends but also local features directly related to climate, topography, botany... the whole ecosystem and its history. The only point *in situ* geochemical measurements do not offer possibility to understand the whole system. They must be supplemented by other surveys. We distinguish therefore the observations made punctually on sampling points SOC those from image database covering the continuity of the geographical space. To complement the field observations we proceed to the identification of plants and plant as well as the characterization of the petrography and granularity face (more than 120 points on the Midtrelovenbreen are observed during 2014 summer). Image data obtained either from satellites either *in situ* acquisition at high spatial resolution by a drone or interpolation calculation and other sources. This gives data on microtopography, climatology, land and thematic indices... (33 FORMOSAT images – from april to september 2007, 2008 and 2009 – are used to map the snow melt rhythm, tri-stereo and stereo Pleiades data (2013) are use to calculate NDVI, LU and DEM, LIDAR DEM and topographical indicators, historicall aerial photographies to map the glacier retreat since the end of LIA, RADARSAT 2 multipolarization for wet index…). The interlinking of spot measurements with image data enables the development of statistical rules in order to generalize to all surfaces considered quantification of SOC – and then not interpolation. Many methods exist in this direction and should be in an experimental phase to test the largest number to validate those that agree to better data, scales and levels of observations. We focuses here on Bayesian probabilities in a way of multilevel, multiscale and multiparameters modelization.

FORMATION PROCESSES OF CRYOCONITE GRANULES IN NORTH WESTERN GREENLAND

Jun Uetake[1], Takehiro Segawa[1], Naoko Nagatuska[2], Nozomu Takeuchi, Hideaki Motoyama, Teruo Aoki[3]

[1] Transdisciplinary Integration Research Center, Japan
[2] National Institute of Polar Research, Japan
[3] Chiba University, Japan
[4] Meteorological Research Institute, Japan

juetake@nipr.ac.jp

ABSTRACT

The cryoconite is dark-colored sediment on glacier surface, which consists of mineral particles from surrounding and biogenic organic matter produced by microorganisms living on the glacier. The cryoconite absorbs solar radiation and change thermo energy causing excessive melting of the ice around and beneath it. Wientjes et al., 2010 shows that similar visible dark colored band called "dark region" is found every summer in the same position at some distance from the margin of western Greenland Ice Sheet. This region was covered by ancient dust mainly deposited in Holocene and photosynthesis microorganisms and microbial organic material significantly reduce the albedo and accelerate the melting. However, forming process of cryoconite granules had not been well described before.

In order to understand the reason for cryoconite formation on certain parts of Qaanaaq Glacier, we will focus on the set of analysis of 6 different size (diameter 30-249μm, 100-249μm, 250-499μm, 500-749μm, 750-999μm, more than1000μm) sorted cryoconite granules. We analyzed carbon and nitrate (CN) amount, and bacterial 16S rRNA gene diversity change of size sorted cryoconite granule. We measured carbon (TC), nitrogen (TN) and cryoconite (CR) mass (g/m^2), then after calculate these ratio (%) in cryoconite granules. TC, TN and CR mass (g/m^2) would show distribution pattern of cryoconite granules on Qaanaaq Glacier, and TC and TN ratio (%) would show structural changes from germination stage of cryoconite granules to mature stage.

The average carbon ratio of cryoconite granules ranged from 0.67 to 5.23% and that of nitrogen ranged from 0.08 to 0.47% throughout all study sites. Average TC and TN ratios of Size 30 – 100 ranged from 0.81 to 1.19% and from 0.10 to 0.11% (Supplemental table 1). Otherwise these of Size 250 – 1000 ranged from 2.10 to 4.54% and from 0.12 to 0.44%, respectively.

After clustering and removal of chloroplast gene sequences, bacterial and archaeal 16S sequence count ranged from 42,606 to 142,147. Taxonomical classification (99%) by Qiime using Silva database shows eleven major phyla (more than 0.1 %) are included in cryoconite granules from different sites and size series. Major phyla represent Acidobacteria (1.0-16.7%), Actinobacteria (3.6-22.4%), Armatimonadetes (0.0-6.0%), Bacteroidetes (12.9-68.5%), Chlamydiae (0.0-0.2%), Chloroflexi (0.0-3.2%), Cyanobacteria (0.1-32.3%), Deinococcus-Thermus (0.0-2.0%), Planctomycetes (0.0-0.2%),

Proteobacteria (12.3-37.8%), WCHB1-60 (0.0-0.1%). Relatively higher minimum ratio of Bacteroidetes and Proteobacteria may indicate these two are widely distributed through samples in despite of differences of sites and size, otherwise ratio of cyanobacteria show gradient between samples. Although total number of OTU in this study is 100,033, we focused top 42 major OTU, which percentage of sequence count against whole sequences (sequence percentage) are more than 0.2%. Most of relatives are from glacier environment in Svalbard, Arctic sea ice, Alaska and High altitude Chinese mountain glacier.