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AN OVERVIEW AND PERSPECTIVE ON CHINESE ARCTIC RESEARCH

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China is not an Arctic country, but its understanding on Arctic linkage has been greatly pushed forward by recent episodes of abnormal climate change in the Arctic. The unusual snow disaster happened in south China at the end of January 2008, for example, has been associated with the unprecedented sea ice retreat in the Arctic Ocean in September 2007. The accelerated melting of Greenland ice sheet has been counted into the cause of more frequent costal disasters, while the open of Arctic passages has drawn great concerns and interests with its implication on international trade and social developments of China.

China initiated its Arctic research program since early 1990s and organized its 1st National Arctic Research Expedition (CHINARE) cruise into the Arctic Ocean onboard R/V Xuelong on 1999. So far, China has dispatched 5 Arctic research expeditions onboard R/V Xuelong and established one Arctic research station at Ny Alesund on Svalbard. The brief history and scientific achievements of the Chinese research expeditions on the Arctic Ocean will be reviewed in this presentation. New research program and capacity building plan on Arctic environments monitoring and investigation will be introduced.

The Arctic is a region where natural change and social developments are closely coupled and both have global significance. Studies on Arctic passages, laws, economics, governance, and geopolitics have been carried out in China intensively in recent years. International cooperation, especially those on Arctic social science between China and Arctic countries, will be strengthened in the future to make comprehensive understandings on Arctic environmental, social, economic and cultural issues. A China-Nordic Arctic Research Center is under exploration to be established between the Polar Network of Strategy Research of China and relevant Nordic research institutions and networks.

NEW KOREAN BI-POLAR OCEAN PROGRAM (K-PORT, KOREA-POLAR OCEAN IN RAPID TRANSITION)

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The bi-polar oceans (the Arctic and the Antarctic) are globally linked, not only through exchange of water and atmosphere but also by the fluxes and dispersal of flora and fauna between the two polar regions. Both regions are experiencing profound changes under the present warming and are predicted to be even more highly impacted under future global change. To understand how climate variability and change will affect these bi-polar ocean systems, it is essential to understand the role of biogeochemical, geological, and physical structure and transport processes between the Arctic and the Antarctic as well as the mechanisms that link the physical characteristics and biogeochemical systems of these ocean areas. The new Korean bi-polar ocean program using the Korea's first icebreaker RV *Araon* (K-PORT, Korea-Polar Ocean in Rapid Transition) has now been developed to detect the changes of structure and processes in the water column and subsurface in the Arctic (Chukchi and Beaufort Seas) and the Antarctic (Ross Sea) regions.



THE PRESENT CONDITION OF ARCTIC ENVIRONMENTAL RESEARCH IN JAPAN AND THE ROLE OF JCAR

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The Arctic environmental research in Japan has been changing quickly in these one to two years, in accordance with the fast change in the Arctic. New GRENE (Green Network of Excellence) Arctic Program started in 2011 and new consortium JCAR (Japan Consortium for Arctic Environmental Research) began, along with the existing research at various Institutes. It can be said that research component and coordination function started at the same time. Overall condition of the Arctic environmental research in Japan and the role of JCAR, will be presented from the Chair of the Steering Committee of JCAR and Executive Director of the JCAR Office.

INTRODUCTION OF ASIAN FORUM OF POLAR SCIENCE (AFOPS)

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Asian Forum of Polar Science (AFoPS) is an international cooperations of polar science in the Asian countries. Malaysia, India, Korea, China, Japan are member and AFoPS has also observer countries.

Objectives of AFoPS are recognizing the importance of international cooperation and aiming to serve the common interests in polar sciences, member countries work together to provide a foundation for cooperative research activities, to present Asian achievements toward international polar communities, to encourage Asian countries' involvements in polar research.

AFOPS's major activities are,

- 1) Provide a forum to seek a common view on polar affairs among member countries.
- 2) Develop and support cooperative programs on polar research.
- 3) Convene joint symposia and workshops for polar sciences
- 4) Support Asian countries to develop their national polar programs.
- 5) Produce joint publications on polar sciences

AFoPS countries have research stations in the Arctic or visiting Arctic stations. AFoPS is willing to contribute Arctic science and effective international collaborations.

NEXT-GENERATION ECOSYSTEM EXPERIMENT (NGEE ARCTIC): OPPORTUNITIES FOR INTERNATIONAL COLLABORATION AND PARTNERSHIP

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The Next-Generation Ecosystem Experiments (NGEE) project will use observations and models to quantify the response of physical, ecological, and biogeochemical processes to climatic change across molecular to landscape scales. Our approach addresses the question *“How does permafrost thaw and degradation, and the associated changes in landscape evolution, hydrology, soil biogeochemistry and plant community dynamics, affect feedbacks to the climate system?”* Field and lab research will focus on interactions that drive ecosystem-climate feedbacks through greenhouse gas fluxes and changes in surface energy balance. These feedbacks will arise due to gradual thawing of permafrost and thickening of the seasonal active layer. Feedbacks will also occur as a result of the threshold-dominated processes of permafrost degradation and thermokarst formation and through the many processes that are influenced as a result of these landscape-scale dynamics. Our approach will consider how components of complex systems are linked and the interplay in space and time that determines system behavior. Fundamental knowledge gained in these investigations will be used to improve representation of ecosystem dynamics, subsurface biogeochemistry, and land-atmosphere processes in regional and global models, and will reduce uncertainty and improve prediction of climate change in high-latitude ecosystems.

The research scope of NGEE Phase 1 is designed to address our overarching science question through a series of integrated field observations, lab experiments, and modeling activities. Permafrost degradation and its impact on water, nitrogen, carbon, and energy-related processes will be investigated across a hierarchy of scales, including the pore/core, plot, and landscape scales. Field research will be conducted in Alaska on the North Slope (Barrow) and Seward Peninsula (Council), U.S.A. Phase 1 modeling efforts will focus on application of existing models to evaluate their predictive capability across a range of spatial scales, from single-column to plot to landscape scales. Model results will be compared with laboratory experiments and field observations at the Barrow and Council sites. We will simulate permafrost degradation in a warming Arctic using the land surface component of a major climate prediction model as well as several high-resolution process-resolving models of subsurface physical and biological dynamics. These integrated experimental and modeling efforts will (1) quantify how permafrost degradation influences surface and subsurface hydrology, (2) resolve biogeochemical mechanisms that control rates of CO₂ and CH₄ flux, (3) characterize the role of nitrogen availability in shrub expansion and plant productivity, (4) identify mechanisms underlying changes in ecosystem net energy budgets due to vegetation dynamics, and (5) quantify prediction capabilities associated with existing models.

Insights gained in Phase 1 will be used to address the challenge of extrapolating process studies to larger grid scales of climate models and to sharpen our scientific hypotheses about physical, chemical, and biological processes that shape the structure and function of Arctic ecosystems. Our goal throughout the NGEE project will be to provide the underpinning science and process understanding required to develop a new generation of high-resolution land surface simulation capabilities for the Arctic.

INTEGRATED LAND ECOSYSTEM – ATMOSPHERE PROCESSES STUDY (ILEAPS)

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The land-atmosphere interface is where humans primarily operate. Humans modify the land surface in many ways that influence the fluxes of energy and trace gases between land and atmosphere. Their emissions change the chemical composition of the atmosphere and anthropogenic aerosols change the radiative balance of the globe directly by scattering sunlight back to space and indirectly by changing the properties of clouds. Feedback loops among all these processes, land, the atmosphere, and biogeochemical cycles of nutrients and trace gases extend the human influence even further.

iLEAPS (Integrated Land Ecosystem – Atmosphere Processes Study, a core project of the ICSU-sponsored IGBP (International Geosphere-Biosphere Programme), is an international cross-disciplinary research program aimed at improved understanding of processes, linkages and feedbacks in the land-atmosphere interface affecting the Earth System. iLEAPS facilitates scientific collaboration as well as synthesis and distribution of results to scientific, political and public audiences. The main activities of iLEAPS include 1) highlighting and advertising important scientific results (newsletters, bulletins, website, synthesis reports and articles); 2) organising science conferences, workshops and trainings around LEAP science; 3) organising and co-sponsoring sessions at conferences; 4) organising the iLEAPS Science Conference that gathers together the latest findings and breakthroughs of the iLEAPS science community all over the world, and most importantly 5) developing LEAP science by starting off new initiatives and projects that focus on land-atmosphere-society interactions and take steps towards global sustainability. One of the foci of iLEAPS research in the next 3-4 years is Arctic research such as the international multidisciplinary initiative Pan-Eurasian Experiment (PEEX).

INTERACT – ACCESS TO THE ARCTIC

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INTERACT is currently a network of 45 terrestrial research stations from all Arctic countries, but is still growing. The network was inaugurated in January 2011 when it received an EU 7th Framework award. INTERACT's main objective is to build capacity for identifying, understanding, predicting and responding to diverse environmental changes throughout the wide environmental and land-use envelopes of the Arctic. Implicit in this objective is the task to build capacity for monitoring, research, education and outreach.

INTERACT is increasing access to the Arctic: 20 INTERACT research stations in Europe and Russia are offering Transnational Access and so far, 3900 person-days of access have been granted from the total of 10,000 offered.

An INTERACT Station Managers' Forum facilitates a dialogue among station managers on subjects such as best practice in station management and standardised monitoring. The Station Managers' Forum has produced a unique "one-stop-shop" for information from 45 research stations in an informative and attractive Station Catalogue that is available in hard copy and on the INTERACT web site (www.eu-interact.org).

INTERACT also includes three joint research activities that are improving monitoring in remote, harsh environments and are making data capture and dissemination more efficient. Already, new equipment for measuring feedbacks from the land surface to the climate system has been installed at several locations, while best practices for sensor networking have been established.

INTERACT networks with most of the high-level Arctic organisations: it includes AMAP and WWF as partners, is endorsed by IASC and CBMP, has signed MoUs with ISAC and the University of the Arctic, is a task within SAON, and contributes to the Cold Region community within GEO/GEOSS. INTERACT welcomes other interactions.

HISTORY AND FUTURE OF THE PACIFIC ARCTIC GROUP (PAG)

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The Pacific Arctic Group was imagined during the Arctic Science Summit Week of 2002 and formed during the International Arctic Science Committee (IASC) Council Meeting in April 2003 as a subunit of IASC with the mission to “Serve as a Pacific Arctic regional partnership to plan, coordinate, and collaborate on science activities of mutual interest”. During the formative years the Group developed a number of science themes that it wished to pursue and adopted a mode of action based on two primary types of activities: 1) enhancement of individual national field programs by inclusion of an international component; and 2) creation of collaborative activities focused on synthesis of data and publication on topics of mutual interest. Descriptions of these activities are available through the PAG website located at <http://pag.arcticportal.org>. The PAG is now distinct from but affiliated with the IASC, and is evolving to meet the needs of its major members (Canada, China, Japan, Korea, Russia, and United States). During and subsequent to the International Polar Year 2007-2009, the PAG members increased efforts on Arctic marine science and are developing a rich set of data to describe the Pacific sector of the Arctic. Discussions within the group have identified new areas for potential collaboration, such as model-data fusion, distributed biological observatory, and studies at the northward-moving sea ice edge. This presentation will highlight some of the accomplishments from these efforts and discuss the continuing role of the PAG in promoting international coordination of research in the Arctic.

ADDED VALUE THROUGH COOPERATION. THE ROLE OF SVALBARD SCIENCE FORUM AND THE RESEARCH IN SVALBARD DATABASE

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Thirteen nations have permanent research stations in Svalbard and in 2012 900 scientists from 33 different nations conducted research in the archipelago. There are occasions of research groups in Svalbard working separately on similar topics in the same locations without cooperating or even being aware of each other. It is clear that given the number of scientists from various nations and disciplines working in such a relative small region, effective mechanisms for research coordination can create benefits for all. Better coordination of logistics and fieldwork, increased data sharing and the use of new technology are all factors, which can contribute to releasing scientific results more efficiently and can also lead to decreasing the environmental impact of our research.

The Svalbard Science Forum (SSF) is a part of the Research Council of Norway (RCN) and promotes coordination and collaborative efforts in research activities in Svalbard. This includes managing the “Research in Svalbard” (RiS) database which contains information on more than 2000 Svalbard-based projects. RiS is established in cooperation with the Norwegian Polar Institute and is a valuable source for information on previous, current and future research activities in the region.

The SSF also organizes workshops and administers strategic funding schemes. These aim at increasing international and interdisciplinary cooperation in Svalbard. The funding also promotes coordination of activities to reduce the environmental footprint of the research activities. This funding scheme is open for applications from all scientists and students active in Svalbard provided the research is in active cooperation with Norwegian institutions.

A major challenge ahead is to ensure the accessibility and open sharing of data from research projects carried out in Svalbard. The planned SIOS (Svalbard Integrated Arctic Earth Observing Systems) infrastructure and data access network will be a crucial part of achieving this goal.



THE ARCTIC MONITORING AND ASSESSMENT PROGRAMME (AMAP)

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AMAP is an international organization established in 1991 to implement components of the Arctic Environmental Protection Strategy (AEPS). Now a working group of the Arctic Council, AMAP's objective is "providing reliable and sufficient information on the status of, and threats to, the Arctic environment, and providing scientific advice on actions to be taken in order to support Arctic governments in their efforts to take remedial and preventive actions relating to contaminants".

AMAP is responsible for measuring the levels, and assessing the effects of anthropogenic pollutants in all compartments of the Arctic environment, including humans; documenting trends of pollution; documenting sources and pathways of pollutants; examining the impact of pollution on Arctic flora and fauna, especially those used by indigenous people; reporting on the state of the Arctic environment; and giving advice to Ministers on priority actions needed to improve the Arctic condition.

AMAP's priorities include the following contaminant groups and issues:

- Persistent organic contaminants, heavy metals and radioactivity
- Acidification and Arctic haze
- Petroleum hydrocarbon pollution
- Climate change
- Stratospheric ozone depletion
- Effects of pollution on the health of humans living in the Arctic
- Combined effects of pollutants and other stressors on both ecosystems and humans

AMAP has produced a series of high quality scientifically-based assessments of the pollution status of the Arctic. Recent assessments published by AMAP are on mercury (2011), persistent organic pollutants (2009), and snow, water, ice and permafrost dynamics (SWIPA, 2011).

THE SUSTAINING ARCTIC OBSERVING NETWORKS (SAON)

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The need for a well-coordinated and sustained Arctic Observing Network that meets scientific and societal needs has been identified in numerous reports and at a variety of workshops and conferences. In November 2006, at the Arctic Council Ministerial Meeting in Salekhard, Russian Federation, Ministers welcomed the International Polar Year (IPY), 2007 –2008, as a unique opportunity to stimulate cooperation and coordination of Arctic research and increase awareness of the importance of the Arctic region.

Further, the Arctic Council Ministers (AC) requested the Arctic Monitoring and Assessment Programme (AMAP), to cooperate with the other AC working groups, the International Arctic Science Committee (IASC), and other partners in efforts to create a coordinated Arctic Observing Network that meets identified societal needs (Salekhard Declaration).

The Sustaining Arctic Observing Networks (SAON) promotes the vision of well-defined observing networks that enable users to have access to free, open and high quality data that will realize pan-Arctic and global value-added services and provide societal benefits. Its goal is to enhance Arctic-wide observing activities by facilitating partnerships and synergies among existing observing and data networks, and promoting sharing and synthesis of data and information. SAON also is committed to facilitating the inclusion of Arctic indigenous people in observing activities, in particular by promoting community-based monitoring (CBM) efforts. Non-Arctic Council countries and international organization will be invited to have a seat on the SAON Board when they participate in the work of SAON.

SAON has been operational since January 2012, where the first meeting of the SAON Board was held. Currently 17 projects have been initiated, but more are under development.

THE INTERNATIONAL POLAR INITIATIVE

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The Polar Regions of the world are undergoing dramatic transformations impacting their environment, economy, and life of local residents. The magnitude and interdependence of the associated challenges and their interdisciplinary nature call for a coordinated, resourceful and informed response from relevant international and national stakeholders. Inaction will lead to serious consequences for current and future generations around the globe. To effectively address the challenges and efficiently use the available resources, a cooperation framework provisionally entitled “International Polar Initiative” (IPI) is proposed. If endorsed by major organizations, IPI will prepare a common Implementation Plan for the development of observing systems, research, services, related education and outreach, and practical applications of scientific knowledge in the Polar Regions. IPI will be instrumental in helping the nations to optimize the use of existing resources and identify the areas where new investments in polar activities are necessary for environmental protection, sustainable development of the regions, and addressing the existing and emerging societal needs. IPI will adopt a forward-looking approach but will be largely built on consolidation of and cooperation between existing polar programs and infrastructure. It will serve as effective means of preserving the valuable legacy of the recently concluded International Polar Year 2007-2008. Communities behind major polar organizations and programmes are invited to review the concept of IPI and provide input to the initiative development.

THE INTERNATIONAL STUDY OF ARCTIC CHANGE: PROVIDING TIMELY, RELEVANT AND ACCESSIBLE SCIENTIFIC INFORMATION FOR RESPONDING TO ARCTIC CHANGE

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The International Study of Arctic Change is an internationally supported program of arctic environmental change research with the overall objective of providing timely, relevant and accessible information for responding to rapid arctic change. ISAC works to enable the research community to transcend national limitations and to enhance arctic research within an international framework. Recent and continuing changes across all components of the Arctic System are having significant impacts on the natural, the human, and the built environment; and these changes are influencing domestic policies and international relations. Future system states are uncertain and the lack of predictability hinders efforts to develop strategies for adapting to and managing a changing Arctic. ISAC provides an overarching framework to integrate diverse programs and projects with the common goals of observing, understanding and responding to arctic environmental change. The ISAC Science Plan provides a vision for integrating research among diverse fields and varied users and stakeholders. This paper focusses the implementation of ISAC, including responding to change initiatives and the inaugural 2013 Arctic Observing Summit, which aims to provide community-driven, science-based guidance for the design, implementation, coordination and sustained long-term (decades) operation of an international network of arctic observing systems within the framework of the Sustaining Arctic Observing Networks (SAON) initiative.