Outline of six-year Japanese Antarctic Research Project phase IX and future prospects

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Understanding the mechanism of changes in the Antarctic subsystem is essential in order to elucidate changes in the Earth system and global environment. The six-year Japanese Antarctic Research Project phase IX centered on main scientific theme of “Investigation of changes in the Earth system from Antarctica” will be initiated from 2016/2017 austral summer season. The following three subthemes will be conducted under the main theme, “Investigation of the whole global atmospheric system through precise observation of the Antarctic atmosphere”, “Investigation of the interaction of atmosphere, ice sheets, sea ice, and ocean from integrated research in areas bordering ice sheets and sea ice” and “Reconstruction of the Antarctic paleoclimate to elucidate changes in the Earth system” The three subthemes are established to understand present and past changes in the Antarctic subsystem in the Earth system, interaction within the subsystem, and the relationship between changes in the Antarctic region and the Earth system
We will introduce the outline of the six-year Japanese Antarctic Research Project phase IX and the three subthemes under the main scientific theme of “Investigation of changes in the Earth system from Antarctica.” The future prospects during and after the six-year Japanese Antarctic Research Project phase IX will be discussed.

Keywords: Antarctica, Earth system, global environment

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New Arctic Research Project "ArCS"

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The Arctic is the place where the changes caused by the Global Warming appear most conspicuously. The changes in the Arctic are not only a concern for local communities who are directly affected by the change, but also for people who live in the rest of the world, because the Arctic plays a special role in the global climate system. On the other hand, with the decrease in sea ice, the possibilities of development of new Arctic sea route and the exploitation of natural resources are drawing significant attention from the world, even from non-Arctic countries. While worldwide attention to changes occurring in the Arctic is growing, the scientific understanding of these changes and the data for analysis are still insufficient to show to the stakeholders how the Arctic changes affect global weather/climate and ecosystem, and what impact these changes have on human society and economy for both sustainable development and conservation of the natural environment in the Arctic region. The scientific knowledge, which provides the base of discussions on governance and international protocols regarding the sustainability of the Arctic, are expected to be developed from private sectors and policy-makers in the world. The research project for the Arctic, called ArCS (Arctic Challenge for Sustainability), was started in the autumn of 2015 as a Japanese national project funded by the Ministry of Education, Culture, Sports, Science and Technology. Under close cooperation with other Arctic projects in the world and working groups of Arctic Council and IASC, ArCS aims to elucidate the changes in the climate and environment and to evaluate their effects on human society. ArCS has three main pillars of its activity, namely, reinforcement of research bases and/or stations in the Arctic, capacity building of researchers (including those in private sector), and promotion of international cooperative researches. The National Institute of Polar Research (NIPR), Japan Agency for Marine-Earth Science and Technology (JAMSTEC) and Hokkaido University are playing the key roles in this project. ArCS will be continued until March 2020.

Keywords: Arctic, holistic research, international cooperation

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Long-term Plan for Arctic Environmental Research compiled by JCAR

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Arctic environment specialists aim to present the research direction over the period of 10 to 20 years for the resolution of environmental issues to citizens concerned with environmental problems and researchers in various fields. Up to now, no long-term plan has focused on Arctic environmental research in our country, hence, it is important to present analyses of the current status and future direction to be taken. It is no exaggeration to say that the fact that this long-term plan has been developed by JCAR has confirmed its existence. This plan reflects the hopes of the next generation of researchers, encouraging forward progress toward common goals by working together. The four objectives are as follows. The first one, which is the background for formation of JCAR, is research on “Understanding of the abrupt-complex phenomenon and elucidation of the mechanisms and impacts associated with global warming enhanced in the Arctic, along with improvement of their future prediction”. In this objective, seven themes have been selected such as amplification of warming in the Arctic. The second one, research to elucidate “Biodiversity in land and ocean, and also the effects of anthropogenic environmental change on ecosystem, not limited to global warming” is divided into terrestrial and marine themes. The third one covers “Broad and important research on the Arctic environment and its fundamental information” and includes three themes such as the geo-space environment surrounding the earth. The fourth objective covers three categories of methods related to the previous themes, “Monitoring, modelling and integration of the two, enabling breakthroughs in environmental research”.

Keywords: global warming, biodiversity, basic research for Arctic environment, breakthrough methods

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The SCAR long-term concept - Horizon Scan

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Antarctic and Southern Ocean science has been carried out to understanding natural variability, the processes that govern change and the role of humans in the Earth system. The international Antarctic community tried 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. The Horizon Scan identified the 80 important scientific questions through debate, discussion, revision and elimination by voting. Related questions were assembled into seven topical clusters: (i) Antarctic atmosphere and global connections, (ii) The southern ocean and sea ice in a warming world, (iii) The ice sheet and sea level, (iv) The dynamic earth beneath Antarctic ice, (v) Life on the precipice, (vi) Near-earth space and beyond - eyes on the sky, and (vii) Human presence in Antarctica.
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. 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. Not only the scientific innovation, sustained year-round, access to Antarctica and the Southern Ocean will be essential. 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.

Keywords: Antarctica, Horizon scan, Long-term concept

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Frontier of Polar Science: toward SCJ Master-plan 2017

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Studies of polar region have been carried out in both Arctic and Antarctic regions. Besides Japan Antarctic Research Expedition (JARE) initiated during IGY, observational studies on the Arctic region have also been active in the last quarter of century. More recently, GRENE (2011-15) and ArCS (2015-19) projects have accelerated Arctic environmental research in this country, and contribution to the understanding of global environmental change is significant.
'Frontier of Polar Science' was, for the first time, submitted for Master-plan 2011 of Science Council of Japan. The current plan has been submitted for 2014 Master-plan, and approved The master-plan 2017 of Science Council of Japan is a minor revision, and therefore the proposal of 'Frontier of Polar Science' for 2017 is based on the proposal in 2014. In this presentation, we will introduce the background history and the submitted proposal for Master-plan 2017. We also would like to continue the discussion for revising our plan for Master-plan 2020, which is expected to be a significant revision. The joint working group of IASC/SCAR will be a place for continuous discussions for 2020 revision.

Keywords: Polar region, Antarctic, Arctic

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Antarctic Large Terahertz Telescope

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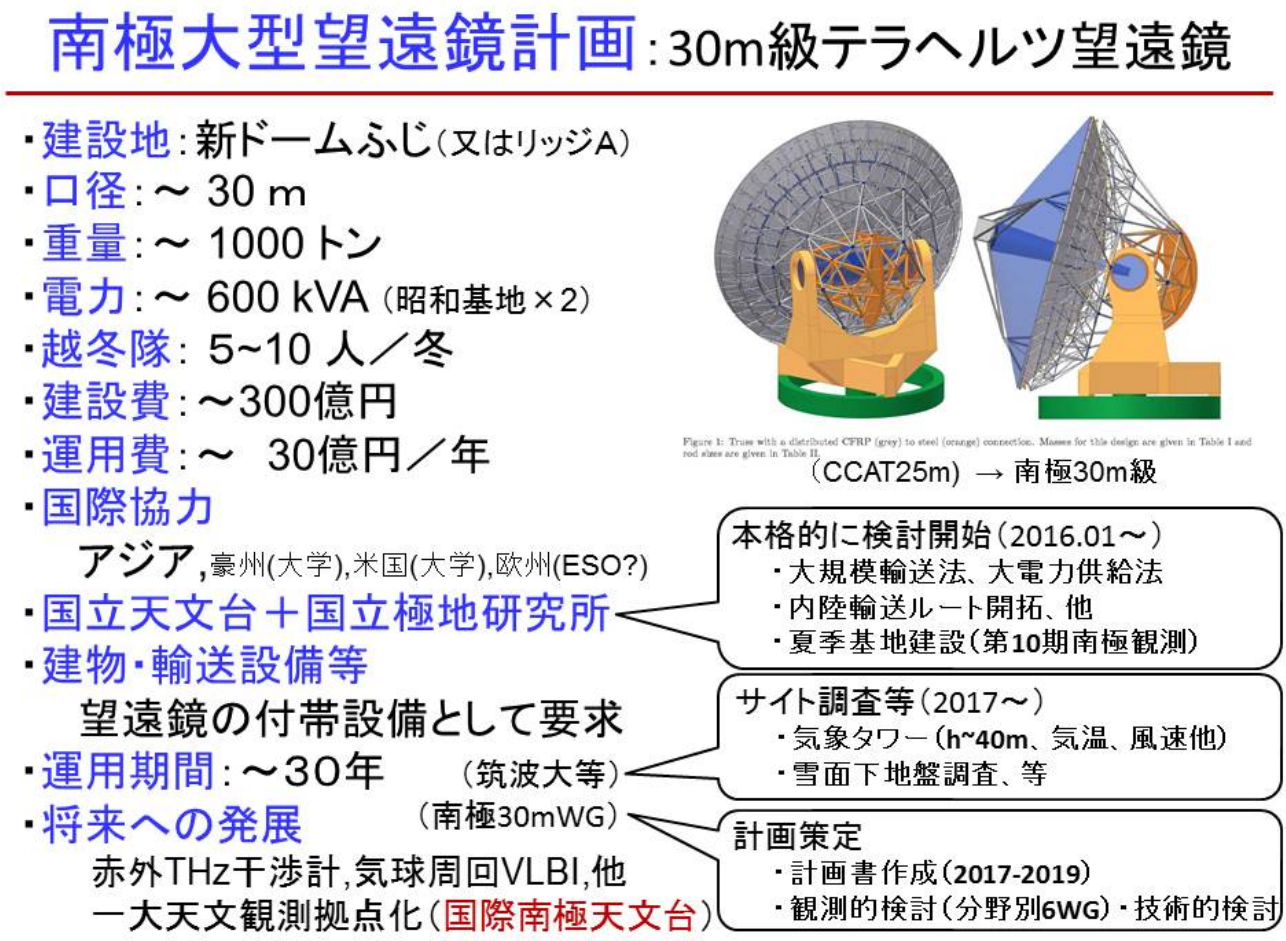
We propose construction of a 30-m class terahertz telescope at the plateaus of Antarctica like the (new) Dome Fuji station to make astronomical observations of cosmology to planets, including large field searching of extremely distant galaxies, at the frequencies of 200 to 1,500 GHz (1.5 THz). For the observations at such extremely high frequencies, a very dry site is required, because the high frequency radio emission from the universe is absorbed by water vapor in the atmosphere of the earth. The plateaus in the inland of Antarctica, which are extremely cold and high altitude and thus the driest on the earth, are the best and unique sites for the observations. We are proposing the project as the next large telescope to the astronomical society under the collaboration between astronomical and polar science societies.

Keywords: astronomical observations, large astronomical telescope, domes in Antarctica



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Long-term field experiment for detection and study of climatological change in East Antarctica

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This presentation will make a review on the Antarctic climatic change during the last decades and discuss important observation to understand the mechanism of the present situation of Antarctica and the future trajectory.
The observational results have clearly indicated that West Antarctica has been warmed up since the middle of the last century, which is one of the areas with the highest warming rate. On the other hand, clear temporal tendency in surface temperature of East Antarctica is not detected. The mechanism of the suppression of surface warming of East Antarctica has not been understood yet.
If we see the tropospheric temperature for the last several decades, the scientific discussion on the temporal change has not been done sufficiently mainly due to limitation in observation. Thompson and Solomon (2002) showed stratospheric cooling tendency mainly responding to ozone hole growth for 1969 to 1998, and discussed it has induced enhancement of tropospheric polar vortex, which can suppress the Antarctic surface air temperature. However, Turner et al. (2006) showed the tropospheric warming tendency. These discussion is based upon very limited data, in particular, radiosonde observation has been operated at the coast of Antarctica, except for the South Pole station. So, at first, we should make effort to operate radiosonde with surface meteorological observation at interior station of Antarctica to confirm that the tropospheric warming tendency is robust feature above whole the Antarctic ice sheet or not.
In the last decade, some remarkable topics were observed in Droning Maud Land. One of the top issues is the extreme accumulation on the lower slope of the ice sheet at 2009 (Boening et al., 2006). The Japanese snow stakes data along the traverse route from Syowa station to Dome Fuji station also captured the same feature. Another issue is a warming event in 2012/13 summer, which would induce surface melting at higher elevated slope of the ice sheet than in normal summer. This warming event was intense one since 1970s for Syowa station, namely, which is a kind of extreme phenomenon. Increment in precipitation and extreme phenomena are the typical features emerged in the global warming, and thus, we should pay attention to the data from East Antarctica in climatological sense.
The purpose of this project are 1) detecting ongoing climatic changes in East Antarctica, 2) specifying the mechanisms together with the relevant processes, and 3) indicating possible trajectories of the detected changes from past to future, focusing on 1) transportation of heat, moisture and aerosols in atmosphere and exchange of those at the surface, paying attention to diurnal variation of boundary layer and katabatic wind circulation in summer and 2) contribution of radiative process forced by clouds, aerosols, moisture, and snow property to change in the surface heating and moisture budget.

Keywords: In-situ observation in East Antarctic interior , Global warming, Climatic system of atmosphere-icesheet-ocean

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Interpretation of both-polar environmental variability through the investigation of sea ice variability

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Sea ice area has been continuously monitored by satellite observations since 1970's. Long-term record of sea ice area to date reveals prominent difference between sea ice areas in the Arctic Ocean and the Southern Ocean. Drastic sea ice reduction has been observed, especially after 1990's in the Arctic Ocean, while sea ice area has gradually increased in the Southern Ocean. Although sea ice variability is considered to be the response to recent climate change, no detailed mechanisms controlling these different results is explained. To understand sea ice variability, which is one of the key mechanisms for global climate variability, the integrated/multidisciplinary investigation is quite indispensable for both polar oceans, where shows different sea ice dynamics. Sea ice variability is affected by the variability of atmosphere, ice sheet and ocean. Also sea ice variability modulates the variability of atmosphere, ice sheet, ocean and ecosystems. The atmosphere-ice-ocean system with their complicated interaction is still unclear, even the research for each process has been carried out. Resolving the mechanisms of this complicated system could contribute to forecasts of climate variability/weather/ice-navigation and conservation of ecosystem. However, few research groups cannot do this kind of effort. Hence, interdisciplinary and comprehensive research activity is needed.
Until now, the investigations in both polar oceans using available satellite observations, numerical simulation, and ice-strengthened vessel have been conducted in Japan. However, observations of the atmosphere above sea ice, the ocean underneath sea ice and ice sheet close to sea ice are big challenges for us due to the existence of sea ice. To overcome this situation, installation of Japanese own icebreaker, which can conduct direct measurements in sea ice area, is most effective solution.
Currently, Japanese research activities are usually conducted on the other country's icebreaker because Japan does not have our own icebreaker. However, the utilization of academic icebreaker will enable us to conduct interdisciplinary observational research covering the atmospheric science, glaciology, oceanography, and submarine geology. Furthermore, interdisciplinary observational research with icebreaker in both polar oceans will contribute to the interpretation of earth environmental variability through the investigation of sea ice variability. Installation of icebreaker, which is needed for breakthrough in polar science and the study of climate change, will open the door which leads to a new stage of global climatic and environmental science.

Keywords: both polar oceans, sea ice variability, atmosphere-ice-ocean system, research icebreaker

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Drilling of deep ice core exceeding 800,000 years for reconstructing past climate

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In the next phase of the Antarctic research activities of Japan, National Institute of Polar Research along with Dome Fuji Ice Core Consortium (ICC) in Japan plan to perform various activities related to drilling of the “oldest ice” with age much older than 800 kyr ago, in the vicinity of Dome Fuji. We call the planned ice core as “the 3rd DF deep core”. In the near future, we aim to: (i) investigate glaciological conditions (ice sheet surface conditions, englacial conditions and subglacial conditions) of the candidate site area; (ii) determine the exact location of the drilling site and (iii) start to perform pilot hole drilling, casing and shallow/middle range deep drilling.

Keywords: Antarctica, ice sheet, ice core

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Holocene paleo-environmental changes of coastal freshwater lakes in Soya Coast, East Antarctica using fossil diatom assemblages

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The East Antarctic Ice Sheet (EAIS) is the largest glacial system on Earth, and documenting its changes is important to understand and estimate its future behavior. Antarctic coastal lakes are invaluable archives of paleoclimate and paleoenvironment changes caused by the retreat of Antarctic Ice Sheet. In Soya Kaigan (Coast) of Lutzow-Holm Bay region, many coastal lakes are located in ice-free areas. Some costal lakes located below 20m ASL are marine relict lakes resulted from the recession of glaciers and subsequent isostatic uplift (Igarashi et al., 1995, Miura et al., 1998). This study discussed the environmental change inferred from microscopic observation of fossil diatom assemblages in a sediment cores from such coastal freshwater lakes, Lake Oyako-ike, Lake Maruwanminami-ike and Lake Maruwan-Oike, in Soya Coast along with biomarkers and microscopic observation of microalgae and cyanobacteria, sedimentary facies and AMS ^{14}C dating.
Diatoms are one of the most common phytoplankton (Class: Bacilllariophyceae), and it is used as powerful and reliable environmental indicators (Cholnoky, 1968; Lowe, 1974) which can be attributed to their high abundance and species diversity. Also, they are distributed among most aquatic environment. Additionally, their cell wall is made of silica (hydrated silicon dioxide) called as frustule, so that their remains are highly durable and well preserved in accumulated sediments as fossils (Smol, J. P., & Stoermer, E. F. (Eds.). 2010). In this study, Diatom analysis was conducted in order to understand past water quality such as salinity when they live on.
The Ok4C-01 core (length 135 cm) from Lake Oyako-ike was divided in 5 zones according to the diatom assemblage changes. This lake has changed from costal marine to freshwater lake at ca. 1100 cal yr BP (core depth 60 cm). The MwS4C-01 core (length 147 cm) from Lake Maruwanminami-ike was also divided in 4 zones. This lake has changed from coastal marine to freshwater lake at ca. 2400 cal yr BP (core depth 65 cm). The Mw4C-01 core (length 226 cm) from Lake Maruwan-Oike was divided in 4 zones as well. This lake has changed from coastal marine to freshwater lake at ca. 2800 cal yr BP (core depth 22 cm). Diatom assemblage changes in these sediment cores show similar pattern with other results such as sediment facies and elemental analyses (TC, TS, TN contents). However, to compare the environmental changes between these lakes, we need more examine the age model.

Keywords: Antarctic coastal lakes, Paleolimnology, Holocene

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Introduction of the ICARP III final Report

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International Arctic Science Committee (IASC, Secretariat: Potsdam, Germany) has announced the final report of the Third International Conference on Arctic Research Planning (ICARPIII). The ICARP is an event which is hosted by IASC, and has been held every 10 years. The ICARP III symposium was held in ASSW (Arctic Science Summit Week) 2015 in Toyama, Japan, and announced Toyama Conference Statement, which became the base of this final report. The “Long-term plan for Arctic Environmental Research”, which is produced by the Japan Consortium for Arctic Environmental Research (JCAR), is referred in the final report.
The final report presented three key messages as Arctic research priorities for next decades: 1) The role of the arctic in the global system, 2) Observing and predicting future climate Dynamics and ecosystem responses, 3) Understanding the vulnerability and resilience of Arctic environments and societies and supporting sustainable development. In addition, communication, traditional and local knowledge, and capacity building are shown as the overarching messages. In the concluding remarks emphases are made on the follows. New approaches, integrating scientific disciplines and bringing in local and regional right holders and stakeholders in a knowledge-based dialogue through trans-disciplinarity, co-designed, solutions-oriented science, and comprehensive, high-quality observations of the rapidly changing Arctic. ICARP III final report clearly emphasizes the importance of knowledge transfer between research community and end-users.

Keywords: ICARP, Arctic, research priorities

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