The Fourth International Polar Year

Japanese Programs

Rev. A

September 2004

IPY-4 Japanese National Committee
Science Council of Japan

The Fourth International Polar Year

Japanese Programs

IPY-4 Japanese National Committee (the Committee hereafter), Science Council of Japan is pleased to publish this leaflet, which is a collection of the programs proposed by Japanese scientists to be carried out in the frame work of IPY-4. The committee hopes, the document describes the outline successfully, how the Japanese scientists intend to contribute to the Fourth International Polar Year.

The collection is by no means comprehensive. The committee did not make efforts to squeeze all possible programs, and assumes many more nice programs will be added at later time.

All the programs submitted are received as they are. The committee did not evaluate the programs in any sense; did not reject a single program or did not attach a program to another one(s) etc. Consequently, individual programs are quite different among others in many aspects, e.g. in the scale of the program. The committee believes, however, none of the program would be disqualified if an evaluation were made in terms of their scientific quality.

The committee made the editorial work absolute minimum.

The grouping of the programs are made only to limited extend. Many programs are located over the disciplinary and aerial boundaries. The precise grouping is difficult and has little meaning at this stage.

The Committee is grateful to the contributors and whishes to proceed with the preparation for the successful IPY together with them.

Tokyo, 1 September 2004

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IPY-4 Japanese National Committee
Science Council of Japan

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Arctic Programs

Research on the wind dynamics in the polar lower thermosphere and mesosphere based on EISCAT/MF/meteor radar observations and simulation predictions

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Related International Research Project
The EISCAT international project

Description of the Program
In order to understand the wind dynamics in the polar mesosphere/lower thermosphere (70-120 km) much more deeply, we have been studying it based on radar observational data as well as simulation predictions. In particular, it is an vital importance to specify the role of the neutral atmosphere though the coupling process between magnetsphere-ionosphere-thermosphere occurring in the polar upper atmosphere. During the IPY4 period, observations of EISCAT radars, MF radars and other at Tromsø (69.6°N, 19.2°E) and Longyearbyen (78.1˚N, 16.0˚E) will be conducted to proceed this project.

Observation of Aurora Fine-structure via INDEX Satellite

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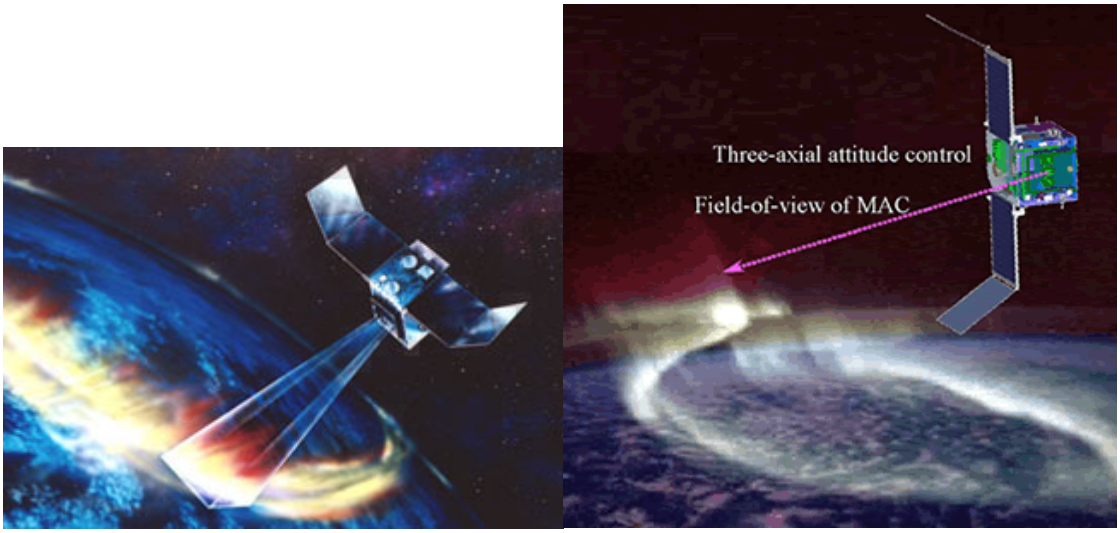
Related International Research Project
EISCAT, Ground Aurora Observation

Description of the Program
Spatial scale of aurora fine-structure is about several 10 meters of thickness. INDEX satellite at the altitude of 680km observes this fine structure of the injecting electrons and 556.3nm, 427.8nm image, as well as hight profile of the aurora.



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Coordinated radar studies of the Arctic and Antarctic middle and upper atmosphere during IPY-4 period (CRSAAMU)

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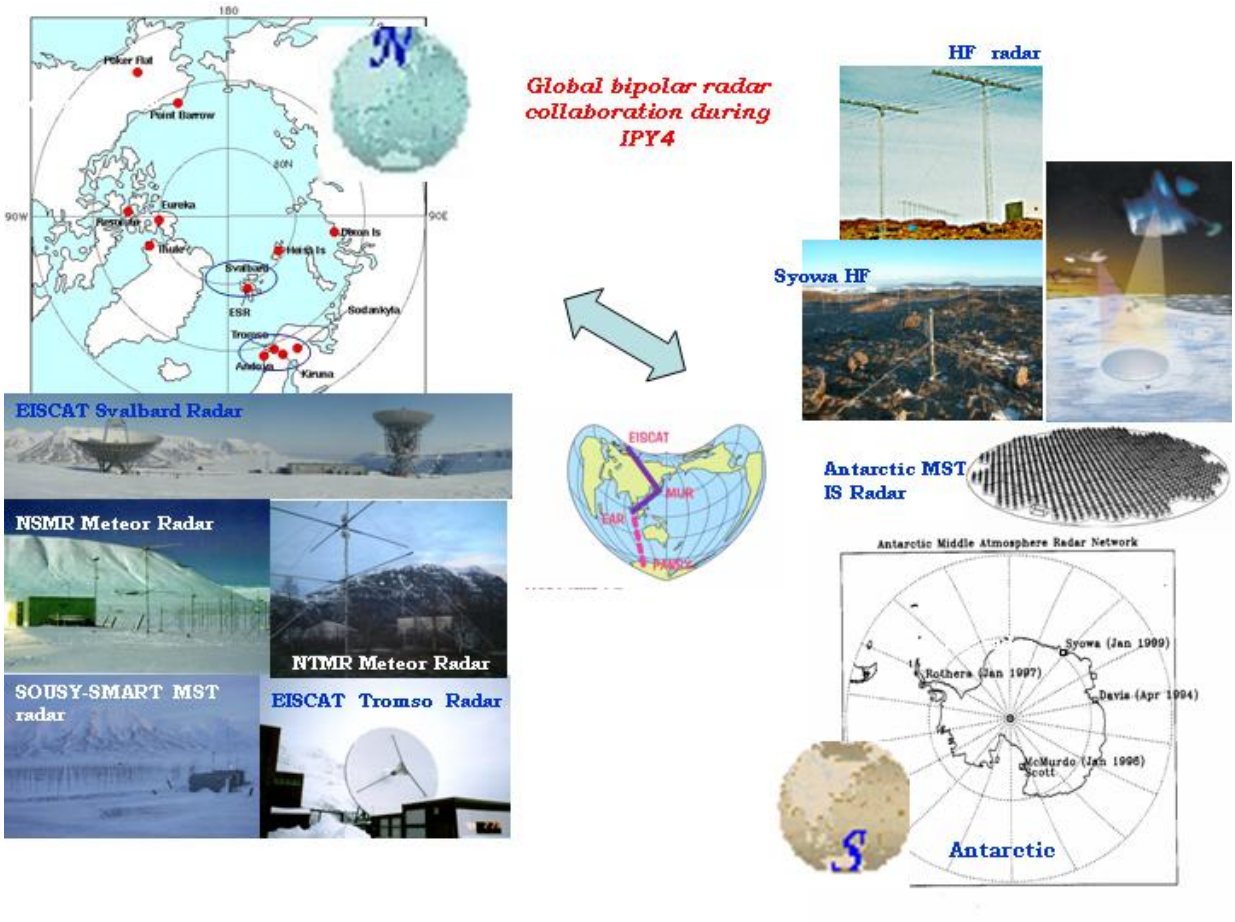
Related International Research Project
EISCAT program

Description of the Program

Description of the Program : Polar middle and upper atmosphere is a key region to study global change in that it is closely coupled to magnetosphere from above which is subject to solar wind and short-wave radiation and to lower atmosphere dynamically where various climatic changes are taking place excited by major insolation and meteorological processes. In addition, atmosphere may circulate into cold polar region and signal from lower atmosphere tends to be amplified in a rarefied higher altitude region. Hence coordinated Arctic and Antarctic radar studies are hence crucial in understanding inherent scenarios which spread out in altitude and global in nature.

The Upper Atmosphere Group of NIPR has intensively been working on EISCAT radar, SuperDARN HF, MF and meteor radars at higher latitudes on international collaborative basis. Also Antarctic area MST-IS radar is now under feasibility study toward IPY2007-2008 for future bi-polar studies with EISCAT and other MST radars in the Arctic. Scientific issues to be pursued by NIPR and collaborators by these radar studies involve aurora substorm, aurora conjugacy in the higher upper atmosphere, plasma-neutral coupling, tide and gravty waves in the upper down to middle atmosphere, and ozone and PSC in the lower atmosphere in view of dynamical coupling of atmospheric layers and asymmetry between Arctic and Antarctic regions.



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Interhemispheric Conjugacy and Non-conjugacy of Aurora and Polar Ionospheric Disturbances

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Related International Research Project
1）ICESTAR (Interhemispheric Conjugacy Effects in Solar-Terrestrial and Aeronomy Research)
2）CAWSES（Climate And Weather of the Sun-Earth System）

Description of the Program
Quantifying and understanding the similarities and differences between the Northern and Southern polar upper atmospheric phenomena, such as aurora, ionospheric disturbances, substorms, under the varying influence of the solar electromagnetic variation and of the solar wind. Main observational methods are the Super Dual Auroral Radar Network (SuperDARN) arrays, magnetometer arrays, imaging riometer network (GLORIA), and optical instruments over the conjugate polar regions.

Japanese CAWSES
(Climate And Weather of the Sun-Earth System)

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Related International Research Project

CAWSES (Climate And Weather of the Sun-Earth System: 2004-2008)

Description of the Program

IPY-4 is scheduled to be held around the end of CAWSES, the next SCOSTEP 5-year international project, which started this year. CAWSES aims at understanding physical processes throughout the entire Sun-Earth system, that is, from the Sun down to the Earth's atmosphere, especially fostering a scientific approach to understanding the short term (Space Weather) and long term (Space Climate) variability of the integrated solar-terrestrial environment, and for its societal applications. CAWSES Science Steering Group in SCOSTEP has organized the following four themes: 1) Solar Influence on Climate, 2) Space Weather: Science and Applications, 3) Atmospheric Coupling Processes, and 4) Space Climatology.

Diversity and Potential Availability of Polar Microbial Resources

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Related International Research Project
No related international research projects

Description of the Program
Objectives.

Extremely cold and dry terrains of the Antarctica are among the most severe habitats on the Earth, and may be inhabited by selected extremophilic or extremotolerant microorganisms, at least more dominantly than in other normal habitats. On the other hand, the Arctic terrains may have experienced microbial successions due to the change in ice coverage by cyclic glaciation and deglaciation. Those polar microbial communities are expected to involve novel and/or beneficial species, and thus the construction of a polar microbial culture collection has been needed. This research program targets at: 1) basic understanding of evolution and phylogeny of polar microorganisms, and 2) industrial assessment of unique characteristics of polar microorganisms as potential biological resources.

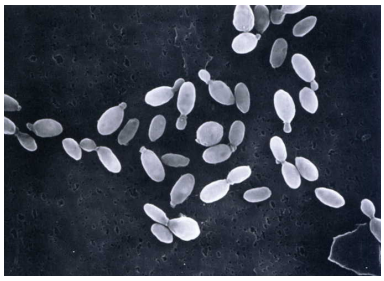
Study sites.

This research program focuses on four study areas of 1) vegetated terrains, 2) dry terrains, 3) ponds and lakes, and 4) glaciers and sub-glacier lakes.

(1) Vegetated terrains: Mosses are the highest plants in the Antarctic vegetation, except part of Antarctic Peninsula. Rich moss vegetations are known and well investigated at Yukidorizawa near Syowa Station (Japan) and Edmonson Point near Terra Nova Bay Station (Italy). In addition, the Arctic field laboratory in Ny-Ålesund, Svalbard, accommodates plant ecological surveys to be linked with systematic microbiological investigations.

(2) Dry terrains: Antarctic deserts are characterized with extreme cold and dryness, which is supposed to be analogous to Martian terrains. These deserts are found in McMurdo Dry Valleys and around Terra Nova Bay Station.

(3) Ponds and lakes: Limonological data of the ponds and lakes near Syowa Station have been accumulated as the results of the Research on Ecology and Geohistory of Antarctic Lakes (REGAL) Project, National Institute of Polar Research (NIPR, Japan), and are available at the web site http://polaris.isc.nipr.ac.jp/~penguin/Terrestrial/regal/DataBase/index.htm.



Microbes from the Vostok ice core (2570 m deep)

Picture in color on the last pages

(4) Glaciers and sub-glacier lakes: Glaciers are regarded as “time capsules” over the past 500,000 years or so, and sub-glacier lakes are taken as “lost world” isolated from the outer world over the past several hundred thousands years. These unique habitats may harbor “less evolved” microorganisms and thus provide mines of “living microbial fossils”. Target sites are the Vostok Station and Lake Vostok (US and Russia), Dome C (France-Italy), and Dome F (Japan).

F-3 Study term.

It will take 5 years to conduct the full-scale investigation at any study sites listed above as follows, and totally 8 years (2007-2014) will be needed if studies at different sites (4 areas) start in different years:

(1) Year 1: General sample collection (for constructing a primary culture collection)
(2) Year 2: Specific sample collection (for determining physiological and biochemical activities)
(3) Year 3: *In situ* measurements of physiological and biochemical activities (working hypotheses)
(4) Year 4: Long-term *in situ* monitoring of targeted parameters (accumulation of continuous data)
(5) Year 5: Test of the working hypotheses

Study methods and requirements.

Standard microbiological methods will be applied, including the following factors:

(1) Logistics: Microbiological samples often require prompt experimental treatments and fast transportation accordingly. Such transportation may include the uses of helicopters and other aircrafts, rather than the surface-moving snowmobiles. It is very realistic that microbiological surveys would make “piggy bag” expeditions on other large-scale flight transportations.
(2) Field laboratories: Microbiological surveys often need temporal or long-term field laboratories for promptest treatments and *in situ* experiments.
(3) Ice-core boring: It is more realistic to conduct ice-core boring with experts from other fields than to do only by microbiologists or to do without microbiologists. Special cares and protocols must be taken into account to prevent or minimize contamination.
(4) Routine protocols: Microbiological sample should be cared for prevention or minimization of unnecessary contamination. Using cared samples, common basic data such as (i) total counts and (ii) 16S rDNA-based microflorae should be collected as routine measurements.

Monitoring of the Global Environmental Change in the Antarctic region

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Related International Research Project
Climate and Weather of Sun-Earth System (CAWSES) project
In order to resolve fundamental questions about variability of the Sun-Earth system, SCOSTEP program called "CAWSES" (Climate and Weather of the Sun-Earth System) is implemented in the period 2004-2008. In our plan of observations in the Antarctic region, measurements of ozone and monitoring of the global environment will be performed at Syowa Station. These observations will provide us important data sets to understand variability of climate and weather due to solar activity, particularly short period variations (e.g., 27-day variations). In addition, we will develop and maintain an observation system to continue long-term observations.

Description of the Program
Overview of the Plan
The Antarctic region is quite unique in the world. The Antarctic Continent lies in the southern polar cap area closed by sea. In addition, the resources of the Antarctic have never been exploited for human activity. We aim to understand the atmospheric

environment and phenomena in the Antarctic region and to monitor global environmental change from the Antarctic by taking advantage of undisturbed environment. We will develop and maintain an observation system to continue long-term observations. The main observation plan is as follows.

1) Monitoring of the ozone variation with balloon measurements

We have developed a balloon-borne optical ozone sensor and have observed lower to upper stratospheric ozone at Sanriku, Japan since 1994. The variation of ozone concentrations over 30 km shows a good correlation with 11-year solar cycle. One reason for this correlation is that ozone in the upper stratosphere is affected chemically more than dynamically. Solar effects in ozone variations are expected to be enhanced in polar region. Continuous measurements of ozone by balloon-borne optical ozone sensors at Syowa Station will provide information of solar effects on the upper stratosphere. We can also investigate the 'ozone recovery' in the lower stratosphere. Some observations show that the ozone decreasing rate becomes smaller after 1996 due to decrease of atmospheric CFC concentration. However, other observations show no evidence of the 'ozone recovery'. It is one of most interesting subjects to investigate when the 'ozone recovery' starts.

2) Monitoring of global lightning and sprite activities with Schumann resonance observations

Recent satellite observations have monitored global lightning activity and suggested a relationship between lightning activity and variability of climate/weather. However, satellite observations cannot cover all the regions in the world simultaneously and never provide temporally continuous data. In order to understand the relationship between lightning activity and climate/weather, global and continuous observations are necessary. Our Tohoku University group has successfully developed a new method for monitoring of global lightning activity using Schumann resonance data observed at three stations: Kiruna (Sweden), Onagawa (Japan), and Syowa (Antarctica). These three stations are deployed globally as forming the best network. In particular, Syowa is necessary not only for the global network but also for high quality data acquisition because of very low artificial noise level without human activity. In order to investigate the link mechanisms between occurrence and activity of lightning/sprites and solar/geomagnetic activities, it is essential to obtain continuous data sets. We will develop and maintain a new ELF observation system to continue long-term observations. Further, the Tohoku University group has an international collaboration with research groups in Taiwan and United States and observes sprite/air glow/aurora with the ISUAL instrument onboard the polar orbit satellite, ROCSAT-II. Coordinated ground-satellite observations will significantly contribute to accurate monitoring of global lightning and sprite activities.

Water transport between the Antarctic ice sheet and atmosphere

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Related International Research Project
WCRP/CliC(Climate and Cryosphere)
Related to the mass balance of the Antarctic ice sheet in CliC program, our plan focuses on water transport between the Antarctic ice sheet and atmosphere.

Description of the Program

The Antarctic ice sheet is made of water transported through the atmosphere and then deposited at the surface. On the other hand, one of the consumption processes is sublimation at the surface toward the atmosphere. This research observes the amount of precipitation and frosting at the surface, and sublimation toward the atmosphere at several points representing the various ice sheet surface environments. Through the observational data analysis and numerical modeling, it aims to clarify the seasonal characteristics and interannual variability in the water transport between the ice sheet and atmosphere. The result must be a fundamental knowledge of the mass balance of the Antarctic ice sheet and also for Antarctic response to the global warming.

The observational terms are precipitation, sensible and latent heat flux at the surface, and vertical profiles of air temperature, water vapor and ice crystals in the atmospheric boundary layer and so on. The areas are a periphery of the ice sheet near Syowa Station, a downstream part of Katabatic wind (i.g., Mizuho Station), an upstream part of Katabatic wind and a summit of the ice sheet (i.g., Dome Fuji Station). These operation are planed to start from 2006 taking about 10 years.

A study on elucidating mechanisms of polar stratospheric ozone depletion using a Fourier-transform spectrometer and balloons at Japanese Antarctic Syowa Station (69ºS)

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Related International Research Project
Network for Detection of Stratospheric Change (NDSC)

Description of the Program

Thanks to the international regulations of emissions of chlorofluorocarbons (CFCs), halons, and major chlorocarbons started by the Montreal Protocol, amount of effective chlorine in the atmosphere reached its peak around 2000. However, the magnitude of ozone hole does not seem to diminish until 2003, when one of the largest ozone hole appeared in the Antarctica. Moreover, it is suspected that increase of green-house gases will lower the stratospheric temperature, increase the amount of polar-stratospheric clouds, and delay the recovery of stratospheric ozone. In this study, we target the elucidation of ozone-depletion mechanisms by measurements of multiple minor gas species which is related to ozone-depletion processes and measurements of types and amounts of polar stratospheric clouds. For this purpose, we will make spectroscopic measurements by a high-resolution Fourier-transform spectrometer (FTIR), and measurements by ozonesondes and aerosol sondes at the Japanese Syowa Station, Antarctica (69ºS), which is located mostly inside the polar vortex during winter.

Antarctic Trace Gas and Aerosol Airborne measurement Study (AGAMES)

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Related International Research Project
Japan-German Airborne Observation program(ANTSYO)
Vertical distribution of aerosols at high latitudes in both hemispheres using airborne laboratories, 2004-2007

Description of the Program

Behavior of greenhouse gases and direct and indirect radiative effects of aerosols have been identified as the key uncertainties for the prediction of the future climate and global warming. Long term monitoring of atmospheric constituents in the Antarctic shows the importance of transport process as well as source and sink. In order to understand source, sink and transport of greenhouse gases and aerosols, their vertical distributions are indispensable to be clarified. Also knowledge of vertical distribution of aerosols is indispensable for the interpretation of past climate from ice core analysis. Air-sea exchange with marine ecosystem is another factor as a source and sink of atmospheric constituents. To solve these subjects, National Institute of Polar Research (NIPR) and Alfred-Wegener Institute for Polar and Marine Research (AWI) have planned a cooperative airborne atmospheric observation in the East Antarctic area around Syowa Station during 2005/06 (JARE 46) and 2006/07 (JARE 47) seasons. This is a part of Japan-German Airborne Observations Program (ANTSYO) including atmospheric and geophysics part, also with other Japanese and European institutions. Also this is a part of bi-polar airborne atmospheric aerosol observation project during 2004 - 2007.

Program of the Antarctic Syowa MST/IS radar (PANSY)

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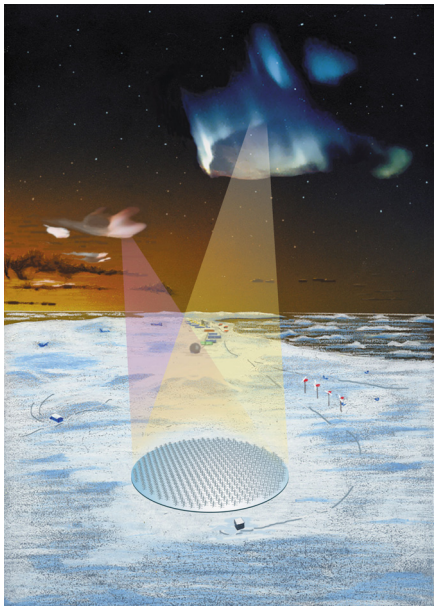

An image picture of the Antarctic Syowa MST/IS radar

Picture in color on the last pages

Related International Research Project

SPARC(Stratospheric Processes And their Role in Climate)/WCRP(World Climate Research Programme)
SCOSTEP(Scientific Committee on Solar-Terrestrial Physics)/ICSU
Recommendation from ***SPARC*** and ***SCOSTEP***, and resolution from ***IUGG, URSI,*** and ***SCAR*** have already been obtained for PANSY.

Description of the Program

PANSY is a plan to introduce the first MST (Mesosphere-Stratosphere-Troposphere) /IS (Incoherent Scatter) radar, which is a VHF monostatic pulse Doppler radar, in the Antarctic to Syowa Station (39E, 69S) as an important station observing the earth's environment with the aim to catch the climate change signals that the Antarctic atmosphere shows. This radar consists of about 1000 crossed Yagi antennas having a power of 500kW which allows us to observe the Antarctic atmosphere with fine resolution and good accuracy in a wide height range of 1-500 km. Main targets of this project are sciences of 1. tropospheric circulation induced by Antarctic katabatic winds in the southern hemisphere, 2. effects on the earth climates by small-scale atmospheric phenomena such as gravity waves, tides,

and vortical disturbances, 3. clouds appearing only in the polar region. i.e. polar stratospheric clouds that accelerate stratospheric ozone destruction, and polar mesospheric clouds that are observed only after the end of 19th century and hence regarded as canary of the earth climate, 4. polar ionospheric disturbances such as aurora with different view points from conventional observation. The comparison of characteristics of atmospheric phenomena in the low and middle latitude region and ionospheric phenomena in arctic region is another important topic of this project. The interaction of the neutral atmosphere with the ionosphere and magnetosphere as well as the global-scale atmospheric circulation including low and middle latitude regions are also targets of PANSY. The observation data with high resolution obtained by the PANSY radar are also valuable for the certification of the reality of phenomena simulated by high-resolution numerical models. The radar construction would start in 2007 and the observation is supposed to continue for 11 years (one cycle of solar activity).

Scientific Traverse in Dronning Maud Land, Antarctica

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Related International Research Project

This plan is going to develop the ITASE program (International Trans Antarctic Scientific Expedition) in the inland region of east Antarctica. The ITASE program is aiming for clarifying the spatial variability of Antarctic climate for the past 200 years.

For the climate records for longer time scale, deep ice cores have been collected from Dome Fuji by Japan, Dome C by European team led by France and Italy, EPICA-DML by European team led by Germany and Vostok by Russia. China is also planning to collect a deep ice core from Dome A.

In order to compare climatic and environmental records of glacial and interglacial period for the past 800000 years clarified by analysis of these deep ice cores, it is necessary to clarify the spatial variability of surface mass balance, the transportation processes of substances including water vapor and the mechanism of transmutation process by various kinds of chemical reaction in the inland region of the ice sheet.

The idea to carry out glaciological investigations by standard methods along the traverse routes linking these 4 deep ice core drilling sites has been discussed by glaciologists from several countries. For a comprehensive plan toward IPY4, there is the

IDEA (Ice Divide of East Antarctica) program proposed by H. Miller of Alfred Wegener Institute, Germany. IDEA program consists of scientific traverses along the East Antarctic ice divide with coordinated logistic support by the related countries.

It is expected that cooperative plans between related countries (for example Germany, France, Italy, Japan, China, Russia) will be discussed in more detail.

Description of the Program

Japan will start the joint inland traverse between WASA and Dome Fuji in cooperation with Sweden in the season of 2007/2008 after the deep ice core drilling at Dome Fuji is completed. Japanese team goes toward WASA via Dome Fuji from Syowa, and Swedish team goes toward Dome Fuji via Kohnen. Both teams join at a suitable site on the route and exchange some people and scientific equipment. They continue the traverse on the way back to each station and complete traverse for a total of 2500 km between Syowa and WASA. Furthermore, Japan is planning inland traverse between Dome Fuji and Dome A in cooperation with China after joint traverse with Sweden.

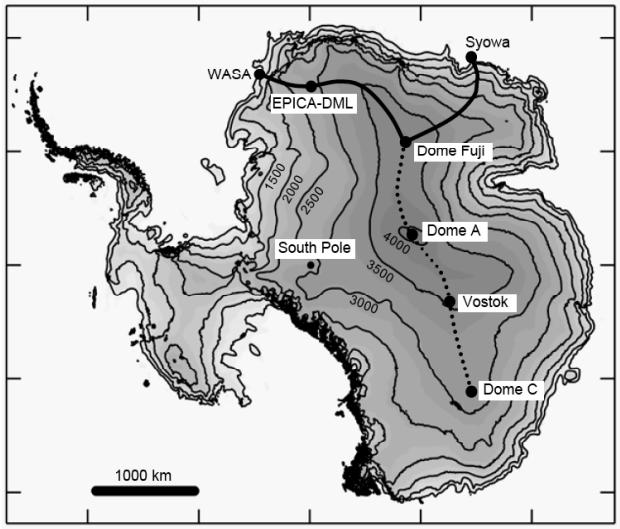
Scientific and observational plans for these joint traverses are planned as follows.

1. "Regional characteristics of atmospheric circulation in the inland region"

The main purposes are to study the atmospheric circulation patterns and to determine transfer function between atmosphere and snow for interpreting result from ice core analysis. Surface snow sampling and pit work will be carried out to study a process of deposition of various substances to ice sheet surface. And automatic weather stations will be newly installed in several sites along the traverse routes to study climatic condition.

- Snow sampling, Snow pit work, Automatic weather station

2. "Change in climate and surface mass balance for the last 50 years and its spatial variability"



Main traverse route, deep ice core drilling sites and related stations

Picture in color on the last pages

For about 50 years after IGY of 1957, weather observation data has been collected in many stations in the coastal region in Antarctica. Furthermore, in the inland region, it is necessary to clarify the spatial variability of surface mass balance and a time series of the past 50 years.

- 10 m coring with hand augur to cover the last 50 years corresponding to IGY 50
- Detection of volcanic events for dating cores: Deception (1976-70), El Chichon (1982), Pinatubo (1991), Cerro Hudson (1991)

3. "Internal layers, surface and bedrock topographies along the ice divide"

It is important to collect information on internal layers within ice sheet and surface and bedrock topographies between deep ice core sites for comparing analysis result from deep ice cores. Furthermore, these provide boundary values for ice dynamics simulation with change in position of ice divide in a glacial and interglacial period scale.

- Surface elevation with GPS method
- Ice thickness and internal layers with ice radar
- Surface snow layer with snow radar
- Snow surface condition, surface roughness and glazed surface.

Monitoring movements of Antarctic Ice Sheet and Glaciers on Coastlines by SAR

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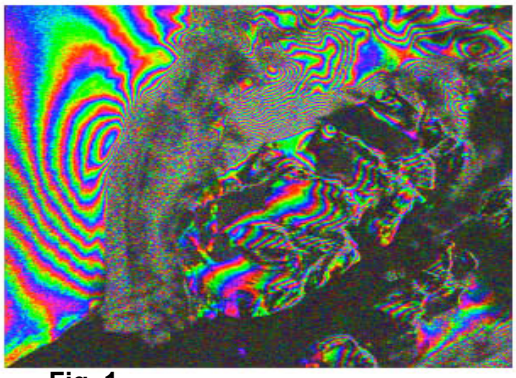

Fig. 1.
Interferogram of
Ice Sheet and Glacier
(Omura *et al.*, 2000)

Picture in color on the last pages

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IAG (International Association of Geodesy) Chair: Makoto Omura (Kochi Women's University, Japan)

Related International Research Project
Working Group (3) InSAR for Polar Regions, Sub-Commission 4.4: Applications of Satellite & Airborne Imaging Systems, IAG, will plan an international research project to apply InSAR for monitoring of surface topography and its change in polar regions. The project will conduct InSAR research for some selected areas on Antarctic/Arctic coastline by applying archived SAR data from JERS-1, ERS-1/2 and RADARSAT or newly acquired data by ENVISAT and ALOS. The WS is chaired by Dr. Omura who is the Principal Investigator of this research program for IPY4.

Description of the Program
Monitoring of surface topography and its change in Antarctica will show movements of ice sheet and glaciers. Studies of the movements will provide some important knowledge

on relationship between the movement of ice sheet or glaciers and climate change. InSAR is one of the best procedures to map movements of ice sheet and glaciers in Antarctica which is very large and is sometimes covered by clouds (Figure 1). However, very rare ground control points (GCPs) prevent quantitative monitoring of the movements. So we will conduct an InSAR program for some selected areas on Antarctic coastline, where relatively dense GCP distribution is attained. Members of this program will analyze the data independently and compare their InSAR results under cooperation with IAG SC 4.4 WG(3) mentioned above. The program will show better way for InSAR in Antarctica and provide snapshots of the velocity field of the movements. The snapshots will archived for future comparison of the movements. JERS-1 and ERS-1/2 SAR data for the Antarctic coastline between East longitude 0 - 90 degrees were received at the Syowa Station and archived at NIPR. Furthermore, ENVISAT and ALOS will observe the areas in the duration of IPY4 (March 2007 - March 2009).

This program aim to provide both better InSAR procedure and basic scientific data in Antarctica

Evaluation of sea ice production and dense water formation / transport in the Indian Ocean sector of the Southern Ocean –towards understanding of the global thermohaline circulation–

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Related International Research Project
This research project has a close relationship with the iAnZone program under SCOR, which focuses on physical processes in the Antarctic Seasonal Ice Zone. The project also constitutes a part of the baseline observations for long-term climate change through Southern Ocean Clivar / CliC, WCRP affiliated programs.

Description of the Program

The Weddell and Ross Seas are thought to be the major source regions of the Antarctic Bottom Water of the world oceans. In recent years, the importance of the bottom water originating in the third region, Indian Ocean Sector, has been widely perceived. There are a few prominent polynyas in this sector and sea ice production there can lead to significant bottom water formation. A bottom water variety originating from the region off Adélie Coast fills the abyssal Indian Ocean and has an impact even in Pacific. The Amery Ice Shelf is located at the eastern end of the Weddell-Enderby Basin, and the bottom water formed in this region would supply a certain portion of the abyssal water to the Weddell Sea or farther

west. Therefore it is important to evaluate the processes of sea ice production, bottom water formation / transport in this sector, towards understanding of the global thermohaline circulation. However, quantitative estimate is still lacking, especially for the direct connection between the sea ice production and bottom water formation.

With hydrographic and mooring observations, this project focuses on the spatial structure and temporal variation of the sea ice production and dense water formation / transport in the A) Amery Ice Shelf and the adjacent region and B) region off Adélie Coast. In spite of the importance of the sea ice thickness in estimating the sea ice production, there have been few time-series observation for the thickness variation. Our moorings are planned to include ice profiling sonars in addition to the standard temperature / conductivity measurements and current meter arrays.

Each component of this project stands in itself as an innovative research activity, and, at the same time, has close relationships with other international programs. The sea ice thickness measurement constitutes a possible epoch-making campaign of the circumpolar observational network. Oceanographic measurements are expected to serve as a part of the baseline observations for long-term climate change.

The project will be fulfilled under the cooperative framework of the related research institutions in Japan. Moorings will be implemented mainly with the resources of the Hokkaido University. Hydrographic observations will be conducted through the close cooperation among National Institute of Polar Research, Tokyo University of Marine Science and Technology, the University of Tokyo, Japan Agency for Marine-Earth Science and Technology, and National Research Institute of Far Seas Fisheries.

Impact of Southern Ocean and ice sheet of Antarctica on the global climate change system

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Related International Research Project
IMAGES (International Marine Past Global Environmental Changes Study, http://www.images-pages.org)

Description of the Program

Past changes in the thermohaline circulation and biogeochemical cycles recorded in marine sediments provide important information with which to predict future global climate change. Since a large part of the Southern Hemisphere is occupied by ocean, the Southern Ocean will have a significant influence on any future climate change there.

With the 2009 cruise of the R/V *Mirai* we will collect sediment cores at ten sites at least in the area of New Zealand plateau and off Adélie Coast (40˚S-65˚S, Fig. 1). We will intend to explore 5 of the most important themes in paleoceanography: 1) timing of expansion and reduction of Antarctic ice sheet and sea-ice distribution of adjacent area of Antarctic continent, 2) timing of south and north migrations of frontal zones, 3) production and reduction of Antarctic deepwater and Antarctic intermediate water, and relationship between intermediate and deep waters, 4) biogeochemical cycles; evaluation of Southern Ocean as a role of sink of CO_2 5) mechanism of production of Antarctic bottom water and changes of Antarctic bottom water temperature and 6) phase lag or synchronization of the sea surface environment between the Southern and Northern Hemispheres. There have been a number of hypotheses for each of these themes and our results will allow us to test them. On the basis of our findings, we expect to be able to define the past environmental

changes throughout the whole of the Southern Hemisphere since the last deglacial period. Our results could also be used to construct a paleo climate model. The post diction of past events is an important test of models. If they can predict the past, then they could predict the future.

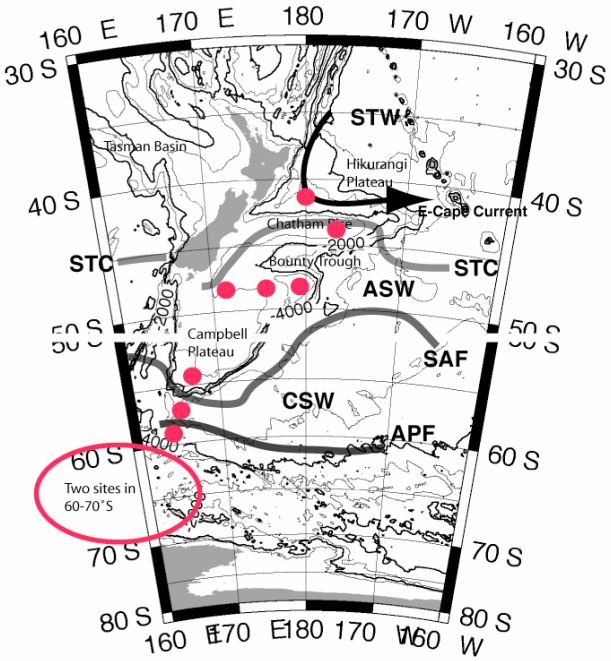

Fig. 1 Sediment coring sites (tentative)

STW:Subtropical Surface Water
ASW: Australian Subantarctic Water
CSW: Circumpolar Surface Water
STC: Subtropical Convergence
SAF: Subantarctic Front
APF: Antarctic Polar Front
● : Coring site

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Geochemical exploration of Precambrian Antarctic meteorite – Aiming to the studies on “tectonics of the solar system” –

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We will ask several persons cooperation for samples and isotopic analyses.

Related International Research Project
Not founded yet. The P.I. serving as an P.I. of Lunar Samples NASA, and
A working group member of geochemical mapping group of IAGC.

Description of the Program

More than 22000 meteorites are listed in the Catalogue of Meteorite 5th ed. by Grady (2000). Most of the stony meteorites, however, classified into only three groups, H, L and LL. The each group seems be correspond to a mother celestial body. The meteorite groups, which have come on the earth, should not be homogeneous during the 4.6 billion years history of our solar system. The possible variation will provide us various hints on “tectonics of the solar system”. Swedish Ordovician meteorites were reported in Journals “Nature” and “Science”.

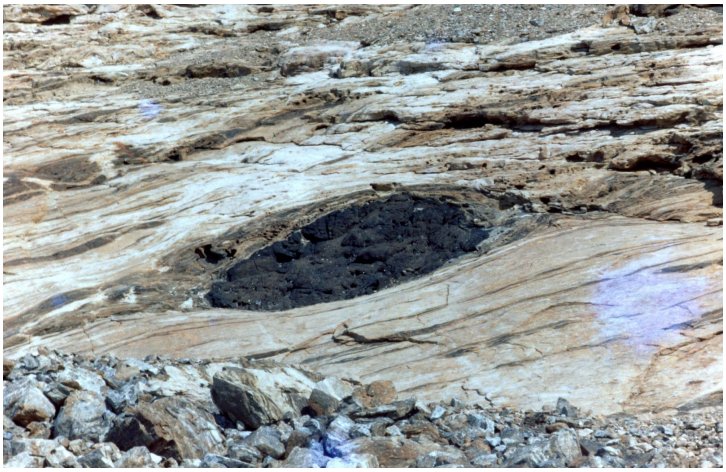
We know many meteorites on the Antarctic ice. We also know many curious mafic and ultramafic nodules in the Lutsow-Holm Complex, East Antarctica. The Lutsow-Holm Complex is a metamorphic complex in granulite facies. The original sedimentary rocks are considered to be formed in upper Proterozoic, probably 1000Ma. Many mafic and ultramafic rocks of a few meters or smaller are included in the Complex.（a photo in below） The source hinterland of these mafic rocks was not found yet. Antarctic geologists regard that the nodules were derived from “extinct hinterland” (Hiroi et al., 1986). We would like to propose another possibility here that a part of the metamorphosed mafic rocks were originally meteorites. Then, we need no hinterland. The current mineralogical textures are amphibolite and could not examine by petrology.

Several mafic and ultramafic nodules are preliminary examined for 28 elements including REE and PGE by INAA. Geological Survey of Japan reference JB-1 and PGE

reagents are use as standards. Allende powder was also analyzed together to check the analytical quality. Several mafic rocks have “chondritic” REE pattern. Lithophile element, however, may not be a good indicator of meteorite, because the surroundings of the nodules are gneiss. It contains lots of lithophiles. The platinum group elements, which are contained in chondrite more than 10000 times of the crustal rocks, must be a good indicator. Osmium and iridium are analyzed in appropriate numbers in Allende chondrite.

We would like to propose the **geochemical exploration of Precambrian Antarctic meteorite** as a new pioneering exploration in Antarctic region to understand the solar system tectonics. We will analyze major and minor elements including PGEs and REEs and Sr, Nd, Ce and Os isotopes for any numbers of mafic and ultramafic nodules in Antarctic region.

The meteorite is accustomed to be named the place where it falls on. The Precambrian Antarctic meteorite falls in our mind. Then it was named as ***“Phantasia”***.



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Developing Plans for Antarctic Seismic Deployments: 'Antarctic Arrays' – For Boradband Seismology on Ice-Covered Continent –

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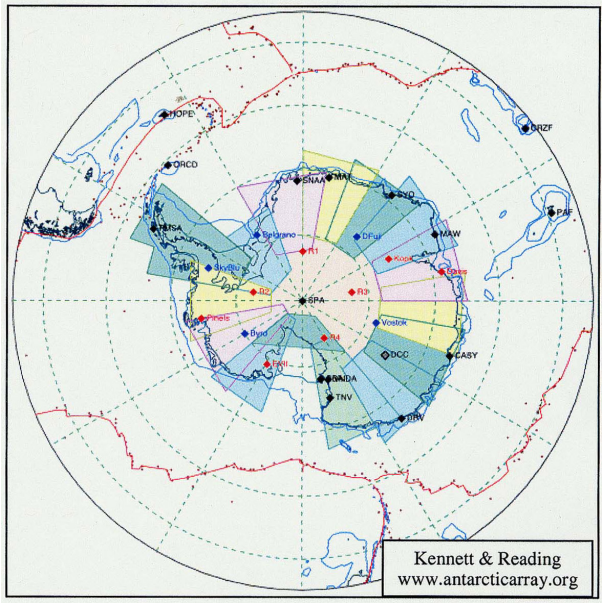
Related International Research Project

Existing seismic stations allows resolution of the structure beneath Antarctic continent at a horizontal scale of 1000 km, which is sufficient to detect fundamental differences in the lithosphere beneath East-West Antarctica, but not to clearly define the structure within each sector. In addition, seismicity around the Antarctic is limited by the sparse station distribution and the detection level for earthquakes remains inadequake for full eveluation of tectonic activity. AntarcticArrays is an ambitious program to improve seismic instrumentation on and around the Antarctica. A science plan designed to improve the understanding of the Antarctic Plate with this Array Deployment is currently under development.

Discussions at the SCAR / ANTEC (Siena, Italy, 2001) and SEAP ('Structure and Evolution of the Antarctic Plate', Boulder, Colorado, 2003) workshops have led to the development of a strategy to radically improve our knowledge of the deep strucutre of the Antarctic plate and the degree of neotectonic actiity within it. The fourth International Polar Year (IPY-4; 2007-2008) may be a good target to initiate this AntarcticArray Deployment.



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Description of the Program

This AntarcticArray's strategy has several components, including 1) process-oriented experiments such as 3D-arrays at SPA; 2) evolving regional arrays; and 3) an enhanced permanent 'backbone network'. More detailed information is described at; http://www.antarcticarray.org/. A present vision for network and regional arrays follows.

Backbone Network; Existing broadband stations of the Federation of Digital Seismographic Network (FDSN) should be supplemented by stations operating year-round with Global Seismological Network (GSN) instrument specification. Technological advances in power supplies and real-time data transmission for remote stations, as well as significant logistical support, are required to implement such a network. Deployment of the backbone network would make a major contribution to Antarctic and global seismology, and would provide an essential framework for regional seismic arrays.

Evolving Regional Array; Deployments of portable broadband seismic stations with horizontal spacing of 200-300 km can delineate major tectonic boundaries beneath the vast ice-covered regions of the Antarctic continent. A strategy of attaining a sufficient density of stations (20-30 instruments) in symmetrically disposed sectors of the continent allows optimal ray path coverage across Antarctica and improves tomographic resolution. Two-three sectors could be deployed simultaneously for 1-2 seasons, then moved to adjacent sectors for the next deployment phase.

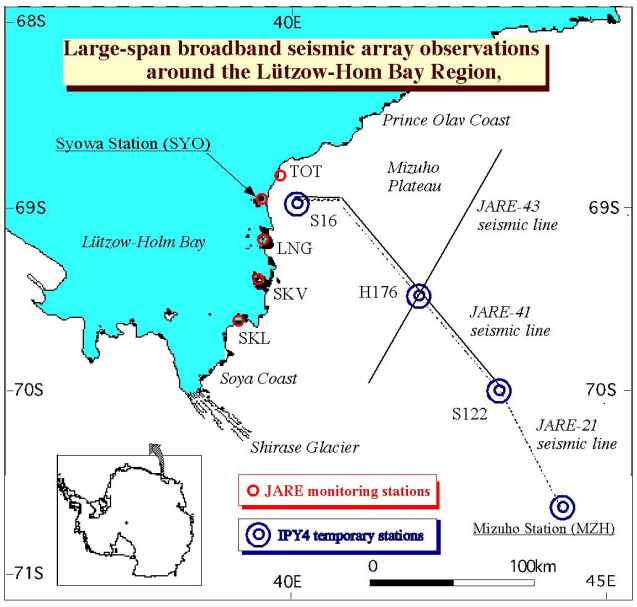
Scientific targets; The justification for an ambitious program to develop AntarcticArrays address both the unique aspects of seismology on Antarctica and general issues that would be common to global seismology; for example:

- lithospheric dynamics in an ice-covered environment;
- how lithospheric processes drive and may be driven by global environmental change (sea

level, climate);
- the scale and nature of rifting as a process that has shaped the continent and dominated its evolution;
- the role of Antarctica as the keystone in the supercontinent formation and break-up throughout Earth's history;
- how the tectonic and thermal structure of the Antarctic lithosphere affect current ice sheet dynamics;
- age, growth, and evolution of the continent and processes that have shaped the lithosphere;
- the effect of improved seismic coverage on global models of the lithosphere, mantle, and core.

International Cooperation; It is clear that this deployment strategy can only be achieved through international cooperation. Nations with winter-over bases (existing or planned) and with logistical capabilities in a particular sector can participate in deployment of permanent stations in the 'backbone network' and / or of portable instruments in the evolving regional arrays.

JARE Contribution; It can be considered to make a cooperation & contribution to the AntarcticArray program in the area of Western Enderby Land – Eastern Dronning Maud Land at IPY-4 seasons. A northern part of this area, particular in the Mizuho Plateau, would most plausible with logistical capabilities to make a deployment of portable stations along the inland traverse routes on the continental ice-sheet. Several remarkable geophysical evidences to reveal the structure and evolution of this area have been achieved by the JARE's geoscientific activities in these few years. By carrying out the broadband seismic deployment on this Plateau, more detailed signature can be obtained concerning tectonics and structure from lithospehre to ascenosphere, together with heterogeneious characteristics of the deep interior of the Earth viewed from Polar region. Moreover, the broadband monitoring observations at several outcrops around the Lützow-Holm Bay area can also contribute to the AntarcticArrays, as stations in the marginal end of continent. In the situation when some deployments will be carried out on Enderby Land area by using air-bone platform from SPA, then we can make an effort to offer the ground support for the installation of seismic stations on ice sheet.



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Shallow marine drilling project for high-resolution reconstruction of East Antarctic Ice and Southern Ocean history during the late Quaternary

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Related International Research Project
The objectives have synergies with other projects working on the Antarctic margin, such as Antarctic Neotectonics (ANTEC), Antarctic Ice Margin Evolution (ANTIME) and Antarctic Climate Evolution (ACE). The results from drill sites targeting the last million years will be of interest to ice coring projects in the interior, Dome Fuji ice coring project.

Description of the Program

The scientific goal of the proposed drilling in the Lutzow-Holm Bay region is to extract high-resolution multi-proxy records of environmental, glacial, biological and climatic change since the last interglacial and to investigate Antarctica's role in Quaternary to recent global environmental change. Drilling will all be accessible by ice surface mobilized drilling systems. It is proposed that a drill rig capable of drilling from sea ice platforms in water depths of up to 600 m and with penetration of up to 10 m below the sea floor will be developed to achieve the scientific objectives of the project. More than ten holes will be drilled per season depending on the water depth and depth of sediment core to be extracted. Since the last interglacial, the East Antarctic ice was much thicker and more extensive. The drill hole proposed will provide a record of these changes to the ice cover and consequent variations in the extent of the sea ice and its effect on ocean circulation since the last interglacial. Coring will be possible to resolve records for East Antarctic Ice and glacier retreat history, sea-ice dynamics and fluctuations in the Lutzow-Holm Bay. Proxy records of sea-ice variability and deep water production from sediment flux/diatom productivity and geochemical markers should elucidate the modulation of the Antarctic Sea super cooling of water masses and sea-ice induced brine production for the oceanic conveyor. The relationship between the Lutzow-Holm Bay record and the coastal climate record from the adjacent area along with the more distant records from Dome Fuji ice cores will improve understanding of high-resolution responses to climate in this part of the

Antarctic. This study will also address the following fundamental questions that surround Antarctica's influence on global climate: (a) What is the frequency and timing of ice sheet and/or sea ice behaviour since the last interglacial?, (b) What was the pattern of East Antarctic ice sheet behaviour when global sea-levels were fluctuated?, (c) What is the role of East Antarctic ice sheet on climate change through the production of bottom water, albedo effects, and ocean-atmosphere heat exchange?, (d) What was the interplay between the Antarctic and Northern Hemisphere cryospheres with respect to temperature, bottom water circulation, CO2 concentration in atmosphere through the biogenic productivity, and sea-level?

Gondwana evolution and dispersal: a perspective from Antarcitca

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Sri Lanka: B. Prame (Geol. Survey), W. Kehelpannala (Inst. Fundamental Studies)
UK: S.L. Harley, N.M. Kelly（Univ. Edinburgh）
USA: E.S. Grew (Univ. Maine)

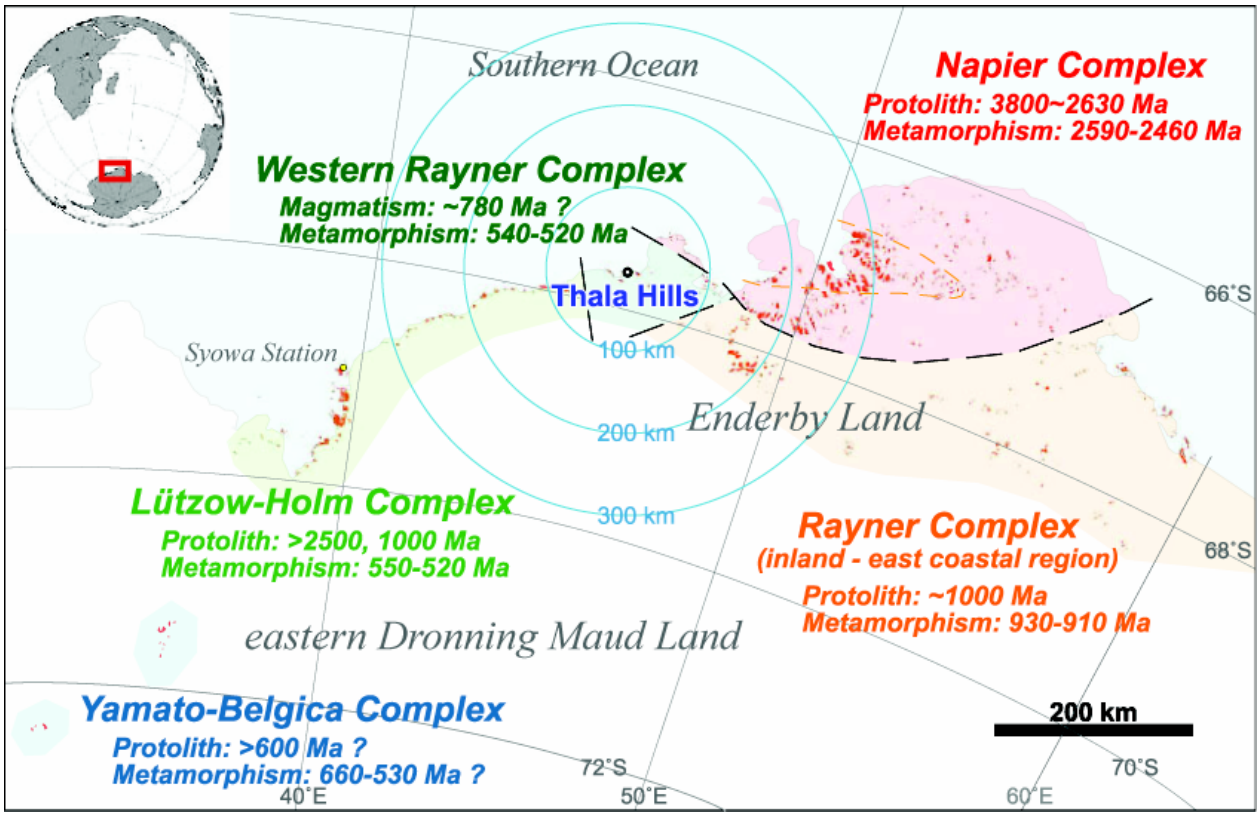
Related International Research Project

GigaGAP (Geoscientific Insights of Greater Antarctica in the area from Gamburtsev Mountains, Amery Ice Shelf to Prydz Bay) which is proposed by Australia and Germany is very close to the present proposal in viewpoint of understanding of the Earth on a global scale. It aims a transect from the centre of the Antarctic continent, from the Gamburtsev Mountains towards Prydz Bay. Although the present proposal put the emphasis on the crustal evolution of the Precambrian to Phanerozoic Earth, both programs reveal the geologic history of a major part of the East Antarctic continent.

WEGAS/SEAL (West and East Gondwana its Amalgamation and Separation/ Structure and Evolution of the East Antarctica) is an Airborne Geophysical Survey in East Antarctica by Germany–Japan collaboration during 2005-07 season. The data obtained through WEGAS/SEAL program is very useful to promote the present IPY-4 program.

Description of the Program

This program aims to reveal the dynamic history of the Earth from the age of the initial crustal formation to the time of the Gondwana dispersal. The East Antarctica where we can observe the long history for 3800 million years is the best field to predict the future of the Earth. The main part of this program is the geological field work using the helicopters because the outcrops on the Antarctica are scattering in the large area and they are difficult to access by means of land transport.



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Studies on Antarctic Ocean and Global Environment

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Related International Research Project
iAnZone (International Antarctic Zone program)
Clivar・CliC (CLImate VARiability and predictability・Climate and Cryosphere)
ANTEC
ANTIME
ACE
SOLAS (Surface Ocean Lower Atmosphere Study
CircAntCoML (Circum-Antarctic Census of Marine Life)- CoML (Census of Marine Life)

Description of the Program

Japanese Antarctic Research Expedition (JARE) has been studying intensively on glaciology, atmosphere science, oceanography and sea ice, biology at Syowa Station on shore as well around Syowa Station including the inland area of the Antarctic Continent. However, the ice-covered sea area off Syowa Station and the seasonal sea ice zone in further north have not been investigated yet. In order to understand fully the history of Gondowana break up and paleoenvironment of the Antarctic continent and the Antarctic Ocean, the intensive investigation by the multi-ship operation in these sea area and zone is very important and essential. The present program proposes to operate an icebreaker and ice-strengthened ship, which are equipped with necessary instruments and observation platform, prepared and arranged by multi-disciplinary research groups as follows;

1. Sea ice production and dense water formation/transport in the Indian sector of the Southern Ocean (PI: Masaaki Wakatsuchi)
2. Gondowana breakup history and paleoenvironment in the Southern Indian Ocean (PI: Yoshifumi Nogi)
3. Shallow marine drilling for high-resolution reconstruction of East Antarctic Ice and Southern Ocean history during the late Quaternary (PI: Hideki Miura)
4. Process study of marine production in the seasonal sea ice zone of the Antarctic Ocean (PI: Tsuneo Odate)
5. Circum-Antarctic Census of Marine Life, in particular to clarify structure and function of meso-pelagic system of the Antarctic Ocean (PI: Mitsuo Fukuchi)

Development of Automatic Research Station Net over the Antarctic Continent

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Related International Research Project
To be established, e.g. WG in COMNAP

Description of the Program

Research Stations have been established in the Antarctica since the time of IGY, and the number of the station becomes greater ever since. The active observation at these stations is bringing us new knowledge about the Antarctica. However, most of the Antarctic Stations are located along the coast, and only few stations are found inland: South Pole Station, Vostok Station, Dome Fuji Station, Dome Concord Station, Heinz-Kohnen Station. Further more, some of the inland stations are summer station, as the logistic requirement for year round operation would be huge and be almost unrealistic.

Considering that the Antarctic is a key component in various global systems, NIPR proposes to establish a research station net, which covers the entire continent in the occasion of IPY-4. The inland stations would be unmanned both for logistic and safety reasons, and should be operated automatically throughout the year. The automatic operation must be possible with the techniques of today, to be precise that of 2007.

The automatic observation equipments, the power supply and the data transmit system have to be developed for inland stations. The researchers in NIPR and other institutions have already started to work on the development of the three components.

The entire concept of the station net must be supported and operated internationally, but Japan will start with a pilot study at a single inland station, perhaps at the location of Dome Fuji, where the unmanned operation of an inland station is to be tested.

Systematic Airborne Observation over the Antarctic

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Related International Research Project
German Airborne Observation Plan
DROMLAN

Description of the Program

The airborne observation covers greater extent in comparison to the surface observation, and gains more detailed information than the satellite observation. The method is especially useful in areas with little number of surface stations as the Antarctica.

The airborne observation has been made in the Arctic to some extent to the present, but the Antarctic airborne observation was started only recently and a fraction of the continent has been observed by the method.

It is proposed to plan a systematic airborne observation net over the continent during the IPY years.

Japan would take care of the area facing to Syowa Station. A temporary air strip is to be constructed on the ice, and the airplane is brought down from Japan either via Novozalevskaya or direct. The machine of a class, Gulf Streem II, is in consideration. The flight along an observation line of ca. 4000km length is planned in a year, and the operation is repeated in the next year(s).

Assuming other countries plan a similar operation over other parts of the continent, the entire Antarctic is covered by the airborne observation lines by the end of IPY-4.

Investigation of the role of the arctic middle and upper atmosphere in global environmental change

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Related International Research Project
'Japan Arctic Monitoring and Process study (JAMP)'
Effects of global climate change are expected to be enhanced in the polar region, particularly the arctic region. The arctic research community in Japan organized a consortium of universities and institutes and is planning a new project named JAMP. This project covers three subjects:
1) Investigation of the climate system in the arctic and circumpolar region
2) Prediction of future climate change
3) Controlling of human-induced global warming
This study is one of the JAMP subprojects and to investigate the role of the arctic middle and upper atmosphere in global environmental change.

Description of the Program
The arctic region plays an important role in the global climate system because the global warming is amplified in this region through the complex feedback system among the atmosphere, land, and ocean. The purpose of this study is to investigate the role of the arctic middle and upper atmosphere in global environmental change and contribute to further understanding of the global climate system. The following 4 subprojects are planned:

1) Measurements of trace species in the arctic region with a Fourier transform spectrometer

The infrared Fourier transform spectrometer (FTIR) has advantages in simultaneously measuring trace species and getting information on their height profiles. There are many stations operating FTIR for the Network for the Detection of Stratospheric Change (NDSC) in Europe and U. S. A. However, there is no FTIR station in Siberia. Siberia is a unique region because it is located inside or outside the polar vortex depending on the movement of the polar vortex. Forest fires in Siberia emit a large amount of carbon dioxide in recent years and wetlands emit a large amount of methane. We are planning to carry out FTIR measurements at Irkutsk, Siberia to investigate chemical ozone depletion in the arctic region and to estimate the emission of greenhouse gases and the trace species emitted from forest fires.

2) Studies of thermospheric/ionospheric variations using Radar Network data in the arctic region

Since recent radar networks are significantly advanced, these networks provide us useful information on temporal and spatial variations of various phenomena occurring in the polar region of both hemispheres. In particular, the Super Dual Auroral Radar Network (SuperDARN), which is the HF radar network, is a powerful tool for understanding two-dimensional structures of the magnetosphere and ionosphere. The European incoherent scatter radar (EISCAT) also provides ionospheric data and neutral wind field in the lower thermosphere which is derived from the data. Using these radar data, we can investigate energy input originated from the solar wind and the energy transfer processes. Recently, there is observational evidence that global warming due to increasing greenhouse gases makes the thermosphere/ionosphere cool. We will be able to contribute to this problem using thermospheric/ionospheric data sets in the arctic region.

3) Studies of the magnetospheric and ionospheric variations using auroral imaging data

We have investigated the quasi-corotating aurora (QCA) by analyzing auroral image data collected by all-sky imagers which are located at Poker Flat, Alaska and operated by National Institute of Information and Communication Technology, Japan. The characteristics of QCA have been investigated from the statistical analysis and simultaneous satellite observations. We have also successfully developed a new method for remote-sensing of magnetospheric dynamics from the motion of QCA. Using this method, we will investigate the coupling process between the solar wind, magnetosphere, and ionosphere. In order to discuss relationships between geomagnetic activities, variations of the middle and upper atmosphere, and the global electric current circuit (coupling between the lower and upper atmosphere through the electrodynamical processes), studies of the magnetospheric and ionospheric variations with QCA will become important.

4) Measurements of sprites in Scandinavia

Lightning-induced emissions such as sprites and elves may play an important role for the global electric circuit between the surface and the ionosphere. We have observed sprites in U. S. A. and Japan, and also started observations at Kiruna, Sweden. The purpose of this study is to investigate activities of sprites in the arctic region and their mechanisms related to the global climate system with optical and electro-magnetic measurements at Kiruna, ELF measurements at Syowa, Kiruna, and Onagawa, and optical measurements with the ROCSAT-2/ISUAL instrument which was developed by a collaboration of the Republic of China, U. S. A., and Japan.

Synergetic observations of dynamics-chemistry-electrodynamics in the arctic middle and upper atmosphere over Alaska

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Related International Research Project
Theme-3 Atmospheric Coupling Processes, CAWSES (Climate and Weather in the Sun-Earth System) (proposed and promoted by Committee on Space Research)

Description of the Program

In the last decade a synergetic observing system centered in Poker Flat Research Range, Alaska, has been developed to investigate dynamics-chemistry-electrodynamics in the arctic middle and upper atmosphere in the Alaskan sector (Figure 1). The observing system includes experiments of atmospheric dynamics (Rayleigh and Na lidars, Fabry-Perot interferometers, monochromatic CCD imagers, MF radar), atmospheric chemistry/aerosol (FTIR, millimeter-wave radiometer, multi-wavelength lidar), and auroral particle precipitations and electrodynamics (imaging riometer, SuperDARN HF radars). Targets of this study include; auroral precipitation/energy distribution and effects to the atmosphere, auroral impacts to the middle atmosphere ozone and further to middle atmosphere temperature, variation of the polar vortex and atmospheric waves, variation of

the mesospheric circulation and relation to the stratosphere and troposphere. One of this study's focuses are the atmospheric processes in context of the Sun-Earth system, especially effects of solar variation to the polar atmosphere processes.

For effective use and distribution of data observed in Alaska, we also developed the System for Alaska Middle Atmosphere Observation Data Network (SALMON) using a high-speed computer network in cooperation with Geophysical Institute and Arctic Region Supercomputing Center of University of Alaska Fairbanks, and international network experiments (APAN, TransPAC, etc) (Figure 2).

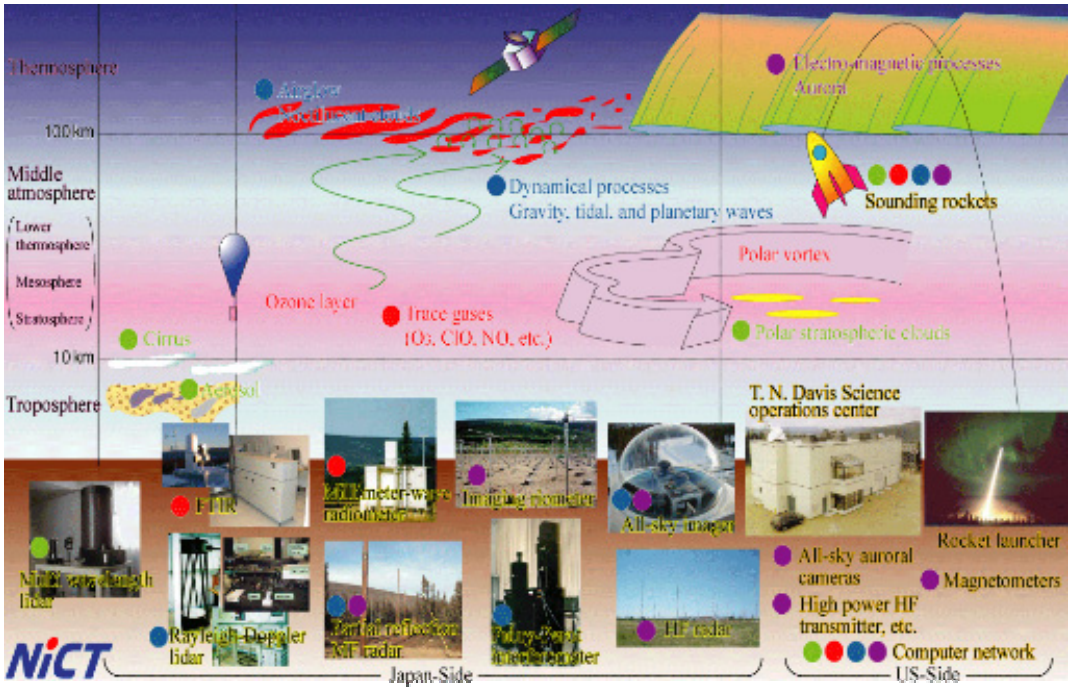

Figure 1. Observation instruments for our project and their targets.

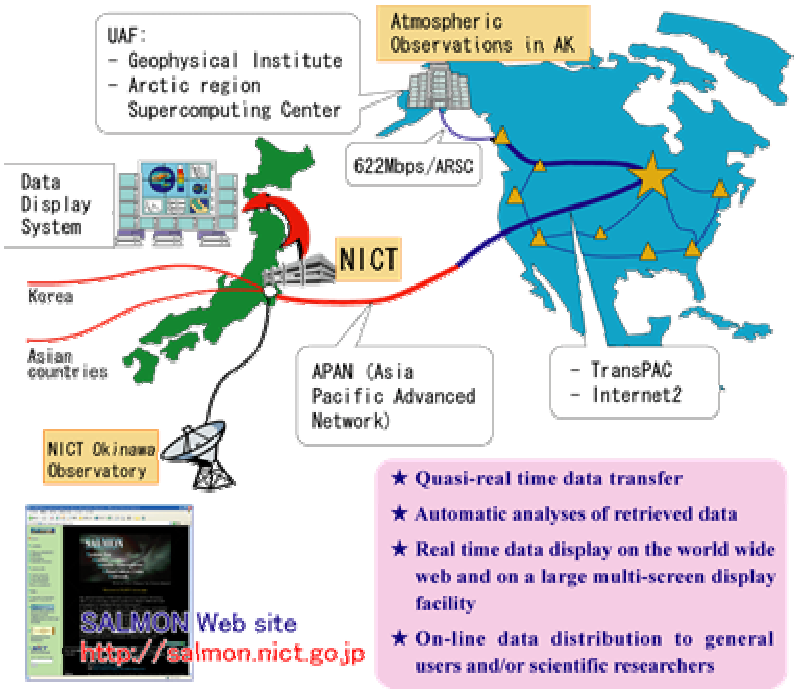

Figure 2. International high-speed computer links for the data network system SALMON.

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Development of the Polar Observing Airship “Vortex Chaser” as an Application of the Stratospheric Platform

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Related International Research Project
Internal Arctic Recearch Center,
Climate of Arctic: Modeling and Processes (CAMP),
Japanese Arctic Monitoring and Process Study (JAMP)

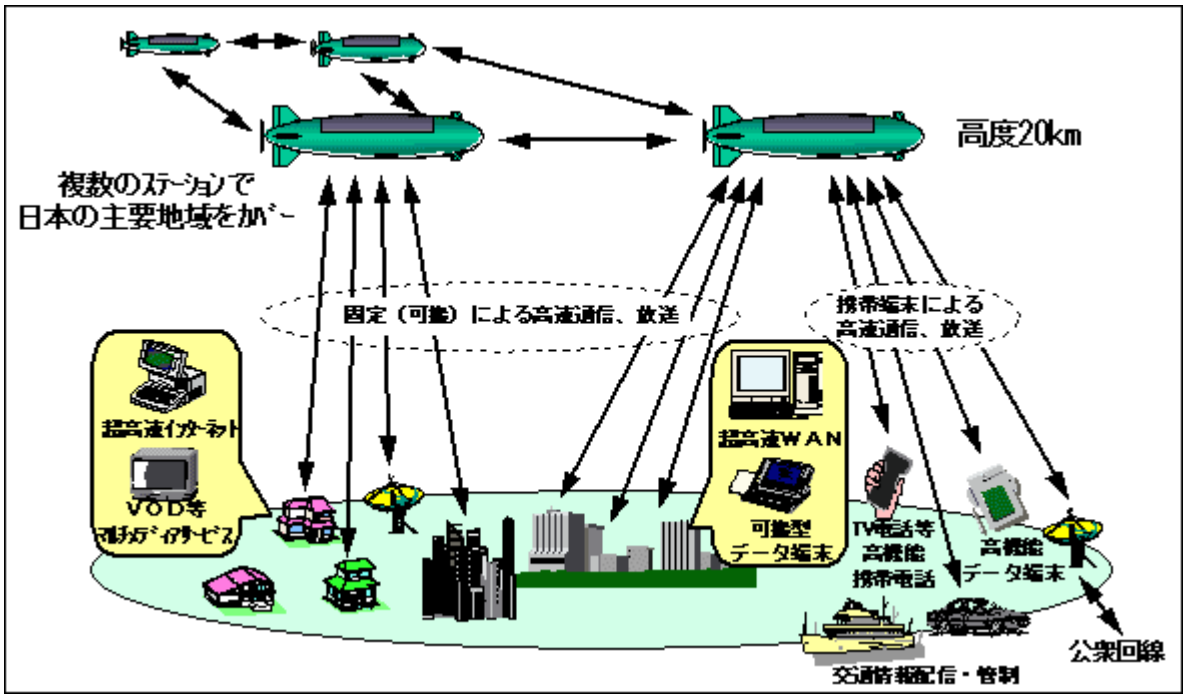
Description of the Program

Observational studies, analysis, and understanding of atmospheric and surface processed in the Arctic are the key problem for the development of the state-of-the-art climate system model. To advance the comprehensive observational system, a new project representing the 21 century will be desired with the target year of International Polar Year (IPY). Arctic observations have been based on a few number of meteorological stations along the coast of the Arctic Ocean, floating buoys, and polar orbiting satellites. Those data are assimilated in to an atmosphere-ocean-ice coupled model to estimate the geographical distributions of the meteorological elements. However, the observational system was not sufficient, especially at the upper troposphere, by a lack of appropriate monitoring system.

The proposed project is to apply the advanced modern technique of the balloon airship of Stratospheric Platform and Balloon Robot for the continuous monitoring of the Arctic in parallel with satellite or airplane observation. In the upper troposphere to the stratosphere, a pronounce polar vortex reside almost all time with a maximum wind speed of 100 m/s along the polar jet stream. Nevertheless, the center of the polar vortex is moderately calm with a lot of sunshine due to the gentle descending motion. Using this environment, we put a huge balloon airship with wide solar panels into the center of the polar vortex. The electric power is stored in the airborne fuel battery which provide sufficient power to chase the core

of the polar vortex. Under the midnight sun from March to September, the balloon airship is supplied by plenty of solar energy, keep chasing the center of polar vortex, and providing important observations over the wade area of the Arctic environment.

Since the balloon airship keeps chasing the polar vortex, we may call it “Vortex Chaser”. Coupled with an accurate numerical weather prediction model data, the Vortex Chaser can move any location in the Arctic, can avoid violent weather, and can accomplish safe landing at the control sites on the land, with possible repeated flights. The proposed project of the Vortex Chaser would be the state-of-the-art monitoring system in the 21 Century over the Arctic, which should be a suitable core dream project of the IPY.



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Study on the past variation of Eurasian Glaciated Regions and Future Monitoring

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Related International Research Project
WCRP/CliC

Description of the Program

Glaciers are produch of Climate, and they respond straightforward to climate change, although there are time lags. Therefore, they are considered important as indicators of climate change. Although the most og the glaciers are retreating under the global warming, there are variation differences among regions, and the process related to it and the type of climate element affecting in each regions are still not clear. Futhermore, the reported fact that high altitude stations show larger warming than lower stations, should have strong impact to the variations, so better monitoring network should be established. If we can collect better cryosphere data, we will be able to obtain better vision of the climate change in the mountains.

The present study will be focusing on Eurasian glacier regions, and the followings will be the objectives

(1) Collect and archive data on glacier variation for the past 100 years, and test the simulation of glaciers using atmospheric data.
(2) Archive the present conditions of the glaciers in various regions.
(3) Construct observation network of the glaciers and meteorology/hydrology of glaciated regions for the purpose of future monitoring.

The study period will be 2006-2010, and following research work will be implemented.

(1) Make measurements on glaciers where there are past records and studies, and depict

the changes.
(2) In relation to GLIMS and other glacier archiving projects, satellite based glacier inventory will be made.
(3) Applying glacier model and using objective-analysis data (such as ERA40), glacier variation will be simulated and compared, for glaciated area where there are good data accumulation.
(4) According to the above analysis, optimum network of glacier monitoring will be discussed, registered glacier/ glaciated regions will be determined, and the glacier measurement/meteorology/hydrology network will be established and prepared.

Environment change in the Arctic Regions and Water Cycle

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Related International Research Project
WCRP/CliC

Description of the Program

Arctic Regions show quite unique surface water/heat exchange system and circulation pattern, and interactions are occurring due to the unique continent/ocean distributions and various land surface conditions such as frozen ground/snow cover/vegetation on the continents. Water cycle is one important component of climate system there, but there are ambiguity/errors on the components such as precipitation, runoff amount and subsurface ice due to poor measurements and lack of stations. The present study hopes to fill this gap by, conducting an intensive observation during the IPY 2007-2008, and obtain more clear vision of the water cycle in the Arctic Regions. The following three are the objectives.

(1) Obtain more high quantitative understanding of the water cycle of the Arctic Regions.
(2) Better understand the continent-ocean interaction.
(3) Construct better observation network for the water cycle preparing for the coming global warming expected.

In order to fulfill the objectives followings will be implemented.

(1) Intensify observation of radio-sonde, surface meteorology/hydrology, precipitation in the northern Eurasia region to Arctic Sea for two years during the period of 2007-2009.
(2) Based on the above measurements, Objective analysis data will be derived from GCM models, and they will be analysed for various researches.
(3) meteorological/hydrological measurements including the basins of non-gauged rivers.

Glaciological investigation in McCall Glacier, Alaska

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Fig. 1 McCall Glacier in Brooks Range, Alaska

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Related International Research Project
None

Description of the Program
[Period]2003-2006
[Area] McCall Glacier, Brooks Range, Alaska, USA
[Purposes]
1) Short period of climatic change in the arctic area by ice core analysis.
2) Formation mechanism of internal ice layers.
2) Glaciological and biological survey of an arctic glacier.
3) Analysis of environmental change by human activities in the arctic region.
4) Investigations of biological activities on a glacier surface.

[Activities]
1) Ice core sampling from the surface to glacier bottom in accumulation area of McCall glacier.
2) Shallow ice-core observation for the formation mechanism of internal accumulation layers.
3) Ice core analysis of isotopes, major and minor chemical contents, pollen, micro-particles and so on.
4) Observation of surface mass balance by a snow stake and a digital-image recorder.
5) Meteorological observation on an accumulation area.

Glaciological investigation in Suntal Khayata Range, East Siberia, for International Polar Year

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Fig. 1 Investigation area in Eastern Siberia

Picture in color on the last pages

Related International Research Project
CliC (Climate and Cryosphere) Project

Description of the Program
In IGY Period, around 1957, extensive glaciological studies were made in Suntar-Khayata Range. In this area the following items will be investigated from 2004 to 2007.
1) Glaciological and meteorological observations of No. 31 Glacier in Suntar-Khayata Range.
2) Mass balance of glaciers in Suntar-Khayata Range.

3) Meteorological observations in Oimiyakon area, where is called “Pole of cold in the world”.
4) Acquisition of meteorological data and sea-ice data around northern Okhotsuk Sea area, Magadan or Okhotsuk, for comparison of climatic change in the arctic area and sea-ice change in Okhotsuk Sea.

Fig.2 No.31 Glacier in Suntar-Khayata Range

Picture in color on the last pages

Spreading pathways of Pacific- and Atlantic-origin waters, and their impact on the ice cover in the western Arctic Ocean

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Related International Research Project

Description of the Program

In the western Arctic, the anomalous retreat of summer ice-edge and the large open water have been observed in the Canada Basin since1997. This anomalous event has been argued in connection with the property and pathway of summer Bering water that inflows through the Bering Strait. Since summer Bering water distributes between the surface mixed layer and the cold halocline, its role as oceanic hear source for the heat budget at the ocean-ice interface is much larger than that of underlying Atlantic water below the cold halocline. A careful analysis of composite T, S structure from a variety sources indicates that summer Bering water changes its major pathway associated with change in Arctic Oscillation (AO) index (Steele et al., 2004).

In 1990's, several modern basin-wide hydrographic sections have built up accumulations of observational data. Up to now, however, hydrographic observations are sparse and necessarily covered space and time inhomogeneously, so that we have to put many pieces of fragmental observations into a jigsaw puzzle to understand the mean state of Arctic Ocean.

Within the Arctic Ocean, it is the ice climate or ice-driven climate. The physical setting will likely be impacted most and first by the change of ice condition, and vice versa. The primary objective of this study is to understand the relationships between the physical environment (oceanic structure and circulation etc.) and the ice conditions. This project focuses the properties and distributions of the substantial water masses such as Pacific-

and Atlantic-origin waters, river-input and ice melt water, in the western Arctic where the retreat of summer ice edge has been remarkable for last several years. The halocline structure is a major issue to be studied as well.
Questions of this study include:

- What is the nature and extent of Atlantic-origin waters entering the Canada Basin via the Chukchi Borderlands and Northwind Ridge?
- What is the pathway Pacific-origin waters entering the Canada Basin via the Bering Strait, and what is its influence on ice cover ?
- What is the spatial and temporal variability of heat and salt in the upper 300m of the Canada Basin?
- What are the annual and interannual signals in the seasonal ice cycle and freshwater inventories of the interior basin?

To ensure this end, we are planning the multi-ship hydrographic observations in the western Arctic Ocean.

Molecular biological evaluation of climate warming effects on activity of the moss ecosystem and moss habitat microbes in Arctic regions

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Related International Research Project

Title: Climate warming effects on moss pathogenic soil borne pathogens (Principal investigator, Motoaki Tojo（JSPS Grants-in-Aid for Scientific Research, no. 15510028, 2003-2006）

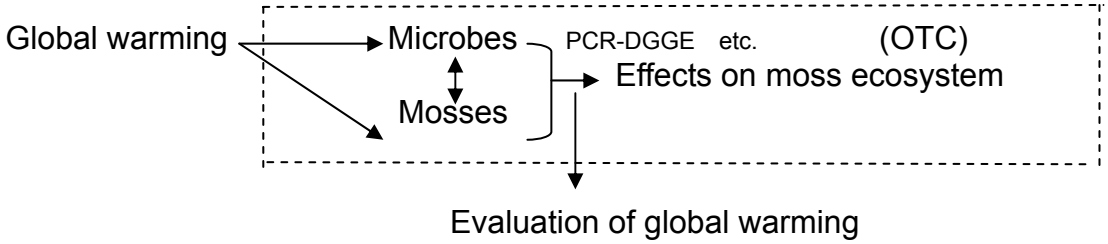
Abstract: Mosses play an important role as primary producer in polar regions. Many dying moss colonies were found in the moss carpets of *Sanionia uncinata* in Svalbard. In our previous results it was suggested that some soil borne plant pathogens were involved in dying of the moss. Climate warming may enhance their activity and lead to dying of moss on Svalbard. Purpose of this study is to clarify effects of climate warming on activity of the soil borne plant pathogens in the moss on Svalbard. The fungal diversity and disease development will be evaluated in every summer from 2003 to 2006 under open top chamber conditions in the field.

Description of the Program

The global warming caused by elevated atmospheric CO_2 has potential effects on terrestrial ecosystems. However, little is known how it affects the moss ecosystems and the microbe-soil-moss root system in the polar regions, where mosses and microbes play an important role as primary producer and degrader, respectively. Increased atmospheric concentration of CO_2 will alter in advance the activity and diversity of mosses, fungi, and bacteria in the moss carpet, and resultantly the structure and function of the moss-soil-microbe system of the polar regions, because it is considered that the global warming has more significant effects on high-latitude regions of the

northern hemisphere than on other places.

The aim of this research program is to evaluate the effect of global warming on microbial activity and diversity in the moss ecosystem by molecular biological techniques. In the field experiments at the Arctic regions such as Greenland, Svalbard, and northern Russia open-top-chambers (OTP) are set on the moss carpets. Every summer from 2005 to 2010 mosses and soils are sampled. Mosses are examined for their biomass and species composition. Disease development of mosses by soil pathogens is also evaluated. Soils and moss roots are subjected to DNA extraction and then polymorphism of microbial rDNA genes is analyzed by the molecular techniques such as PCR-DGGE (polymerase chain reaction-denaturant concentration gradient gel electrophoresis).



Complete Assessment of Carbon Allocation by Ground Ranging and Echoing for Arctic/Boreal Regions

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Related International Research Project

Description of the Program

CACA GRANDE is a multinational campaign to assess complete carbon budget of the Arctic/Boreal terrestrial ecosystems using airborne laser altimetry (ALA) and ground penetrating radar (GPR). With immediate target on arctic-boreal North America to be eventually expanded to Scandinavia, Siberia and Russian Arctic, the project aims 1) to resolve the issues of missing carbon, 2) to answer the needs for quantifying terrestrial carbon flux in accordance with the Kyoto Protocol, and 3) to institutionalize a long-term monitoring of carbon flux in the Arctic/Boreal regions, where the warming due to increasing anthropogenic greenhouse gasses is expected most conspicuous, and as a result, significant bio- and cryo-spheric changes are expected.

Response of Arctic tundra ecosystem and carbon cycle to climate change

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Related International Research Project
ITEX (International Tundra Experiment), IASC-GCTE, FATE(Feedbacks and Arctic Terrestrial Ecosystems)

Description of the Program

Current global warming predictions indicate that warming will be more pronounced at high latitudes in the Northern hemisphere. Since 1994, we have been studied the vegetation change, quantitative estimation of the carbon flow among the atmosphere, plant and soils at glacier foreland in both regions of Ny-Alesund, Svalbard (79oN) and Ellesmere Island (82N). The aims of the project are to study the biological response to environmental change in the glacier foreland, and to understand the pattern of the carbon cycle (light-, water-, and temperature- photosynthetic responses, potential net primary production).

Early Detection of Boreal Forest Fire

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Related International Research Project
JAMP Japanese Arctic Monitoring Program
CAMP Community Arctic Modeling Program
IGBP NES

Description of the Program

Under the global warming trend, arctic boreal forest fire occurrences tend to increase. In 2003 more than 20,000,000 ha of forest burned. These large scale boreal forest fire gives a great impact to carbon budget in atmosphere and terrestrial ecosystem.

If we take into account the fire occurrence and its influence from the view point of carbon budget, boreal forest is no more sink but source of carbon to atmosphere. As to reduce the forest fire occurrence and damages to ecosystem, it is important to improve the detection algorism using Satellite images. The international cooperative program of early detection of boreal forest fire is under the way to establishment based on consortium among universities and institutes in Japan and foreign countries.

Response of permafrost to climatic change

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Related International Research Project
JAMP (Japan Arctic Monitoring and Process study)
CAMP (Climate of the Arctic: Modeling and Process)

Description of the Program

In Alaska, transected lines, running in the east-west and north-south directions will be established, and continuous observations of the permafrost structure and its response to global warming in this undisturbed area will be made. The emission of the greenhouse gases from the permafrost surface will be also monitored. Observational sites will be established at Fairbanks in the discontinuous permafrost area and Barrow in the continuous area.

Chemical processes of the atmosphere in the circumpolar region

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Related International Research Project

Description of the Program

Carbon monoxide and volatile organics compounds (VOCs) which are emitted from boreal forest fires in Siberia are monitored using ground-based Fourier spectrometer systems. Transportation processes of those gases over Siberia, Alaska and Japan and photochemical reaction processes which generate tropospheric ozone are studied. The Fourier transformed infrared spectrometer system is installed in Irkutsk, Siberia and long and short term variations of atmospheric concentrations of CO, O3 and VOCs are measured. In-situ, high-sensitive and fast-response instruments for atmospheric methane and stable isotopes of carbon dioxide are developed using cavity ring-down spectroscopic techniques with lasers. The developed instruments are used for estimations of the emission rate of methane and carbon dioxide from swamps affected by boreal forest fires in the Siberia and Alaska. The effects of aerosol on air pollution and on local and global climate are studied by the sampling and analysis of aerosols generated by Siberian forest fires in Siberia and Alaska.

Development of Control Method Using Satellite Monitoring

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Related International Research Project
There are two related international research projects. They are JAMP(Japan Arctic Monitoring and Process study) and CAMP(Climate of the Arctic: Modeling and Process). International Review Meeting on the Northern Environmental Change Research Project was held at Sendai in March 2004. Both research projects were reviewed and got high evaluation. This research is one research field of JAMP.

Description of the Program
By using satellite data of MODIS and NOAA, early detection method of forest fire occurred in boreal forest in Siberia and Alaska will be developed. In addition, fire propagation simulation to reduce further fire damage will be carried out based on various field data. Both system of early fire detection and fire simulation will be developed.

Remote sensing of carbon budget in boreal forest in Alaska based on component spectral characteristics

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Related International Research Project
IARC (International Arctic Research Center) research using satellite data

Description of the Program

The total carbon storage in boreal ecosystem including tundra and boreal forest is larger than that of the total tropical and temperate ecosystems by about 40%, while the area extent of boreal ecosystem is close to only half of the total tropical and temperate ecosystems. Combined effects of low annual air temperature and moist soil caused by impermeable permafrost in spite of low precipitation repress decomposition of organic matters and store large amount of carbon under the ground. Recently, some observations indicate boreal forest fire causes irreversible changes on permafrost and boreal forest itself. Some model simulations predict global warming takes place especially in high latitude zones, suggesting increase of forest fire occurrences and turning of boreal forest into carbon source. Estimation of carbon budget in boreal ecosystems is necessary for predicting global warming and according environmental changes and rapid counter plans for them. Boreal ecosystems spread in wide area and estimation by not only field observations and model analyses but by satellite remotely sensed data is required.

Previous studies estimated global distribution of terrestrial Net Primary Production (NPP) by calculating fraction of Photosynthetically Active Radiation (fPAR) or leaf area index from normalized ratio between satellite near infrared and red bands, and considering plant growth models, temperature precipitation, and etc. The NPP value, however, does not include soil respiration and does not account separation of forest floor processes from

those of upper layer. Especially, boreal forest has less upper layer vegetation than tropical rain forest and temperate forest, and difference on moss types in forest floors and underlying permafrost status affect on the carbon budget.

The objective of the study is to evaluate the estimation method of Net Ecosystem Productivity (NEP) distributions in interior Alaskan boreal forest from remotely sensed data based on component spectral characteristics from the viewpoint of variability of component spectral characteristics and relationships between forest floor spectral characteristics, soil respiration, and forest floor carbon accumulation ratio.

The new estimation method of Net Ecosystem Productivity (NEP) distributions in interior Alaskan boreal forest from remotely sensed data will be evaluated from the viewpoint of variability of component spectral characteristics and relationships among forest floor spectral characteristics, soil respiration, and forest floor carbon accumulation ratio. Finally, we evaluate the method by comparing NEP of field observation and that of satellite estimation in twenty forest stands that have different characteristics. The model gives the separation of the forest floor processes from those of upper layer. The separation is not included in previous global NPP mapping models with remotely sensed data, though some of the forest floor NPP in Alaskan boreal forest reaches to 30-40% of the total NPP. The knowledge obtained in this research plan will suggest the general methodology of NEP monitoring by satellite not only in interior Alaska but in other boreal ecosystems where forest floor productivity can not be ignored.

Change and Recovery of Hydrological Process Affected by Forest Fire in Arctic Area

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Related International Research Project

Description of the Program

The hydrological cycle in boreal forest is very peculiar due to permafrost existing broadly. For example, river discharge, groundwater recharge, and route of subsurface flow are considerably different between north and south facing slopes. A major effect on these phenomena is caused by the difference of permafrost distribution between these slopes. In arctic region, however, this kind of hydrological characteristics is changing due to permafrost melting as the global warming. And in Alaska and Siberia areas, boreal forest fires are occurring frequently owing to human activity, resulting that the permafrost melting is accelerating and hydrological characteristics are changing. In these regions, lots of wetlands also exist. The vegetations in both of wetland and boreal forest are growing on the base of characteristic hydrological conditions controlled by permafrost distribution. Therefore, to make forest conservation and remediation it is very important to understand quantitatively the role of the hydrological cycle in these regions.

We intend to clarify the water movement, water and energy budget around permafrost in boreal forest region, interior of Alaska. Field observation will be conducted at

both sites of natural forest and forest fire area. Meteorological elements, flow rates of rivers, and water levels under the surfaces are measure observational components. From these observations, we estimate evapotranspiration rates, river discharges, subsurface water flow, groundwater recharges. The survey of permafrost distribution and vegetation will also be conducted. From these data, we analyze and make clear quantitatively the relationship between the hydro-meteorological conditions, the permafrost distributions, and the vegetations. In the final analysis, a hydro-meteorological model around permafrost will be constructed by integrating these data, in order to predict the change of hydrological cycle due to global climate change and forest fire.

Three teams will be constructed to study following subjects; (1) observation and analyzing the hydrological process, (2) studying the interaction between hydrology and vegetation, and (3) making the hydro-meteorological model. Each team executes the study in cooperation with the other teams.

Structure and function of circumpolar biomes and its re-evaluation

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Related International Research Project
JAMP: Japanese Arctic Monitoring Program
CAMP: Community Arctic Modeling Program
IGBP-NES: International Geosphere-Biosphere Program,
Northern Eurasian Studies

Description of the Program

There are three major biomes in the circumpolar region: northern forest, forest tundra, and tundra. These biomes are subject to severe environmental conditions, which are affected by permafrost types and its distribution. Though circumpolar region has been characterized as a uniform and zonal distributed biome, however, it is not uniform and simply zonal distribution. For example, dominant forest species in North America and western Eurasia are evergreen conifers, while deciduous conifer Larix is dominant in central and eastern Siberia where continuous permafrost is widespread. More precise estimation for structure and function of these biomes are necessary to predict global warming effects.

We are planning to make comparative ecological research network among Northwest Territories Canada, Interior Alaska, and northeastern Eurasia, including sporadic/discontinuous/continuous permafrost region. We will start monitoring research on carbon storage, biomass allocation pattern, nutrient cycling and stoichiometric measurements in order to re-evaluate the biome structure and function.

Development of the large scale estimation scheme of greenhouse gas budget at arctic terestrial ecosystems by applications of BIOME-BGC and remote sensing techniques.

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Related International Research Project
Internal Arctic Recearch Center, Climate of Arctic: Modeling and Processes (CAMP),
Japanese Arctic Monitoring and Process Study (JAMP)
NSF Biocomplexity in the Environment, 2004-2007

Description of the Program

Arctic ecosystem holds huge amount of carbon as soil organic carbon, and it becomes greenhouse gases sucgh as carbon dioxide (CO2) and methane (CH4) in relation to the global warming. Methane is the second strong greenhouse effect gas in the atmosphere. Alaskan vegetation includes large amount of flooded and wet surface, and the moist and flooded vegetation have been thought to be a large CH4 source in the northern hemisphere. However, the numbers of observations are limited because of its difficulties caused by location accessibility and management of site and the low atmospheric CH4 concentration.

The estimation of greenhouse gas budget in Alaskan ecosystem with reasonable accuracy is quite important and has been required, and the results will be expected not only

great contributions to global change studies, but also an important information to the local development of forest in Alaska. Thus we plan the proposed research to estimate greenhouse gas budget as its changes in time and space by combining satellite and in situ observation.

The goal of the proposed research is to understand a spatial and temporal variations of greenhouse gas budgets in Alaska, so that several approaches are applied to get better estimation. Continuous flux observations are the most important study, one of which was established at permafrost forest (taiga) in UAF campus from 2002. As the tower flux observation provides only a point data but provides temporal variations. On the other hands, satellite image provides spatial distributions of vegetation, surface change by wildfire and snow cover which will affect greenhouse gas budget. Objectives for the research goal are;

1) Clarify the spatial pattern of greenhouse gas budget applying soil map, vegetation map, satellite data showing current surface changes, and relationship between tower fluxes and meteorology.
2) Detect the seasonal variations of vegetation condition (sprouting, development, senescence) and snow cover by satellite images.
3) Estimate greenhouse gas budget using above results.

The current prior study will be conducted to verify the research approach; at first we detect the vegetation type and its distribution by using satellite images, and then the relationship among tower flux data, soil type, vegetation type and meteorology are applied. Then, the spatial differences and seasonal variations are estimated for some vegetation.

During the examination of grand truth data and model/satellite images, NSF funded NSF Biocomplexity in the Environment, 2004-2007 is the partner of the Japan-US collaboration research, both of Japan and US researchers can share the results and expand the estimation scheme from coastal tundra at Barrow (north) to interior Alaska taiga at Fairbanks (south).

Dynamic response of arctic river basins to global warming and forest fires

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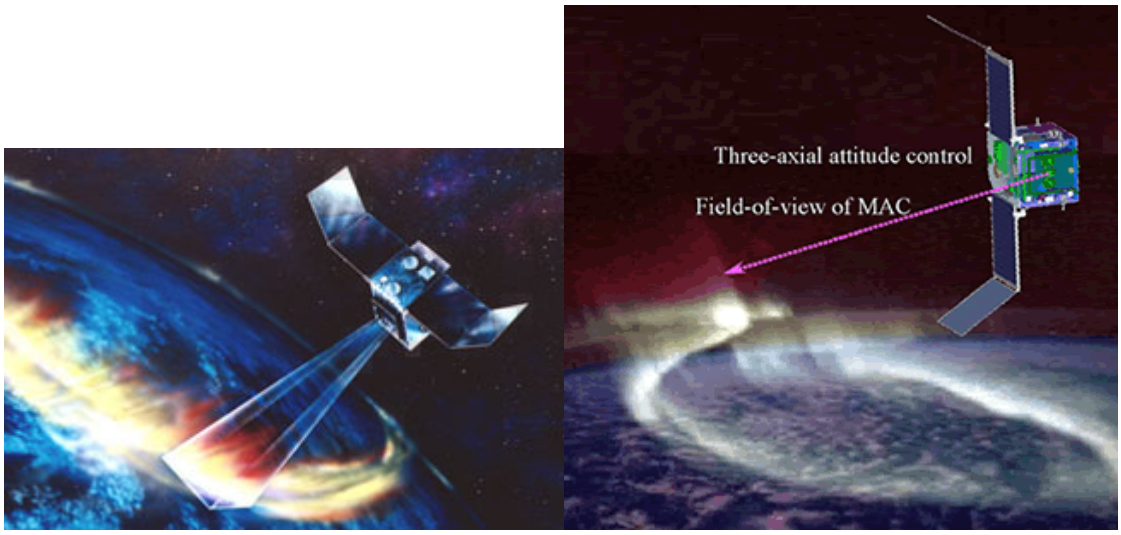
Related International Research Project

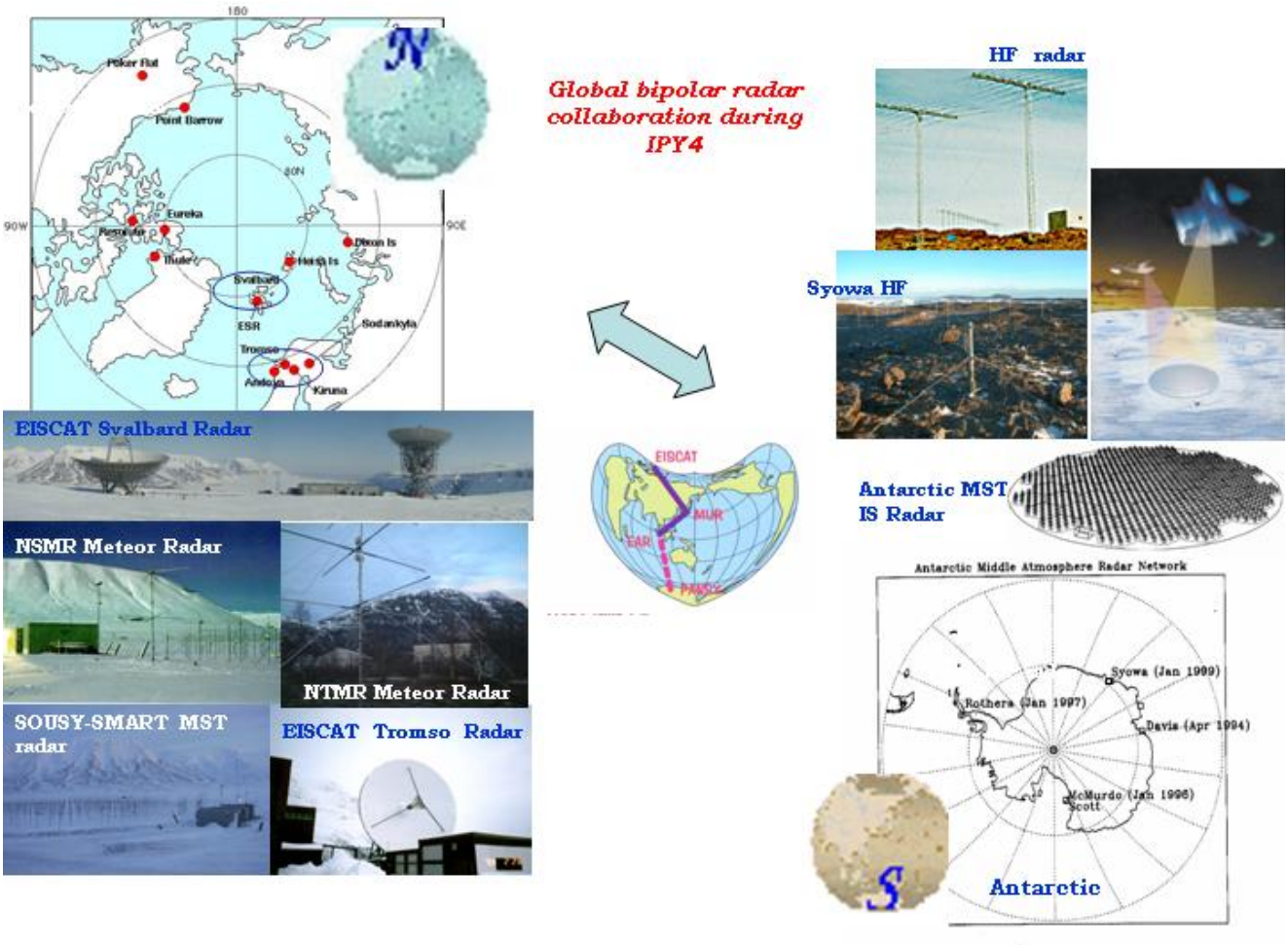
Description of the Program

Yukon River, Alaska is recharged by glacier-melt in headwater regions, ice-melt in permafrost regions and snowfall and rainfall in almost all regions. Especially, the glacier-melt, being highly sensitive to high temperature by global warming and to smoke conditions by forest fires, controls the river discharge. Water and sediment discharges and meteorology will be monitored in the Yukon River basin. Physical models will be established for prediction of the two discharges.

p 2　Principal Investigator,　Masaki Okada



p 4　Principal Investigator,　Takehiko Aso



p8
Principal Investigator,
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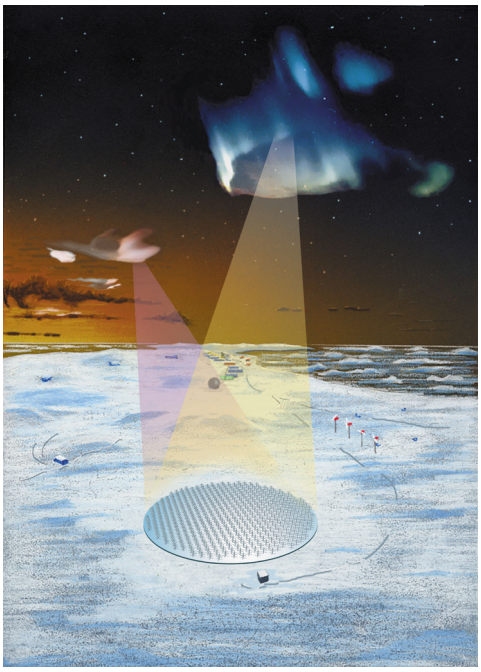
Microbes from the Vostok ice core
(2570 m deep)

p14 Principal Investigator, Masaki Ejiri



An image picture of the Antarctic Syowa MST/IS radar

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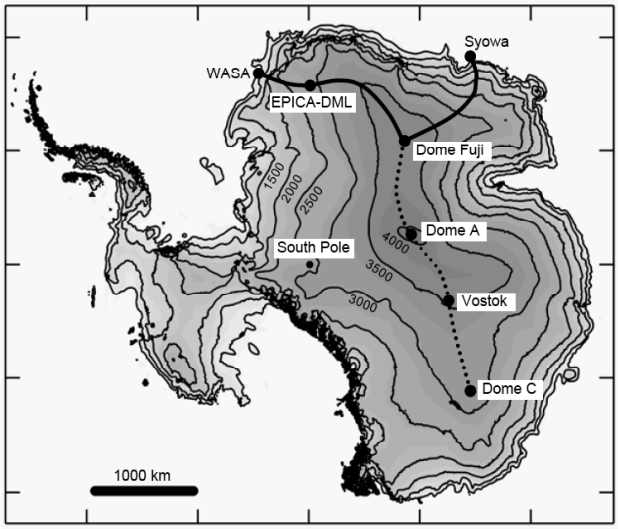

Main traverse route, deep ice core drilling sites
and related stations

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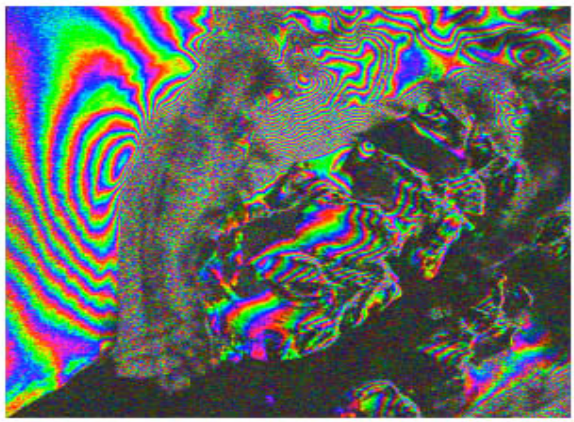

Fig. 1.
Interferogram of
Ice Sheet and Glacier
(Omura *et al.,* 2000)

p23
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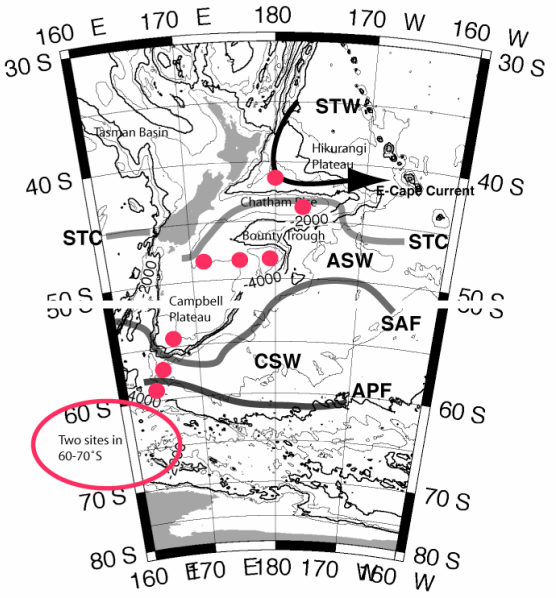
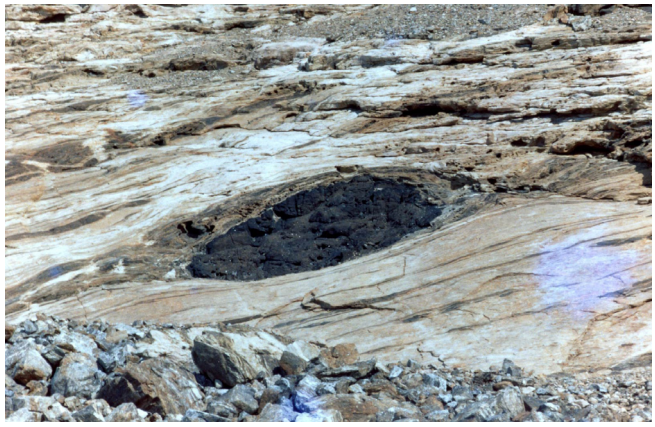


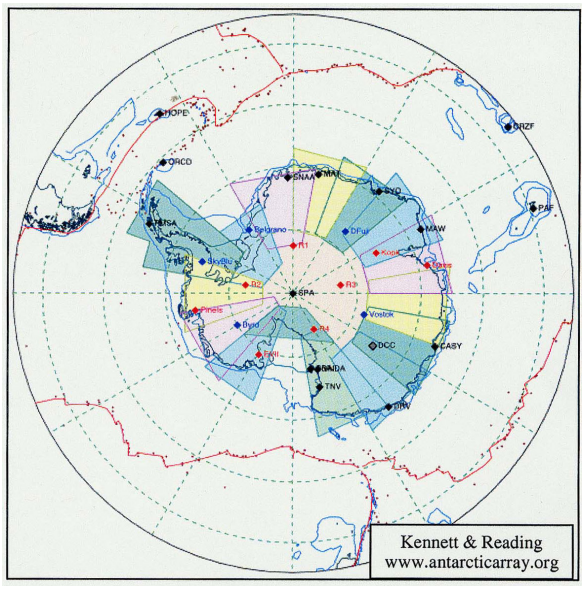
Fig. 1 Sediment coring sites (tentative)

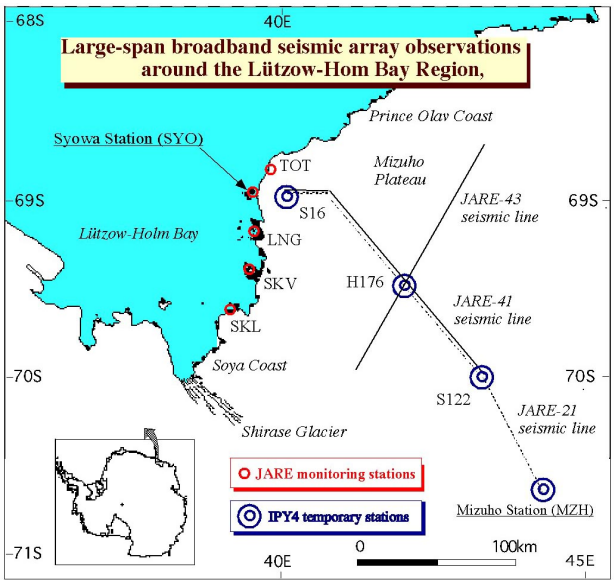
STW:Subtropical Surface Water
ASW: Australian Subantarctic Water
CSW: Circumpolar Surface Water
STC: Subtropical Convergence
SAF: Subantarctic Front
APF: Antarctic Polar Front
● : Coring site

p25 Principal Investigator,
Tsuyoshi TANAKA,

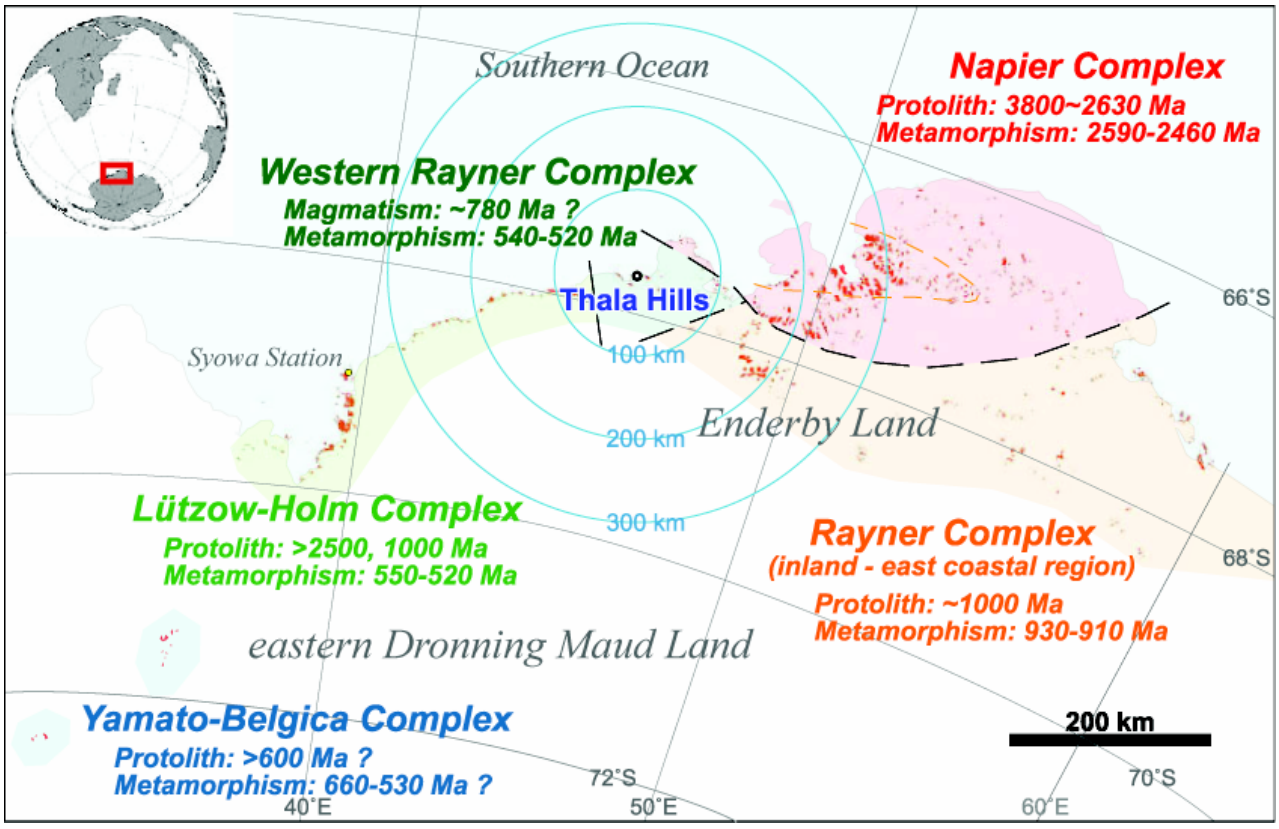


p 27－28 Principal Investigator, Seiji Tsuboi

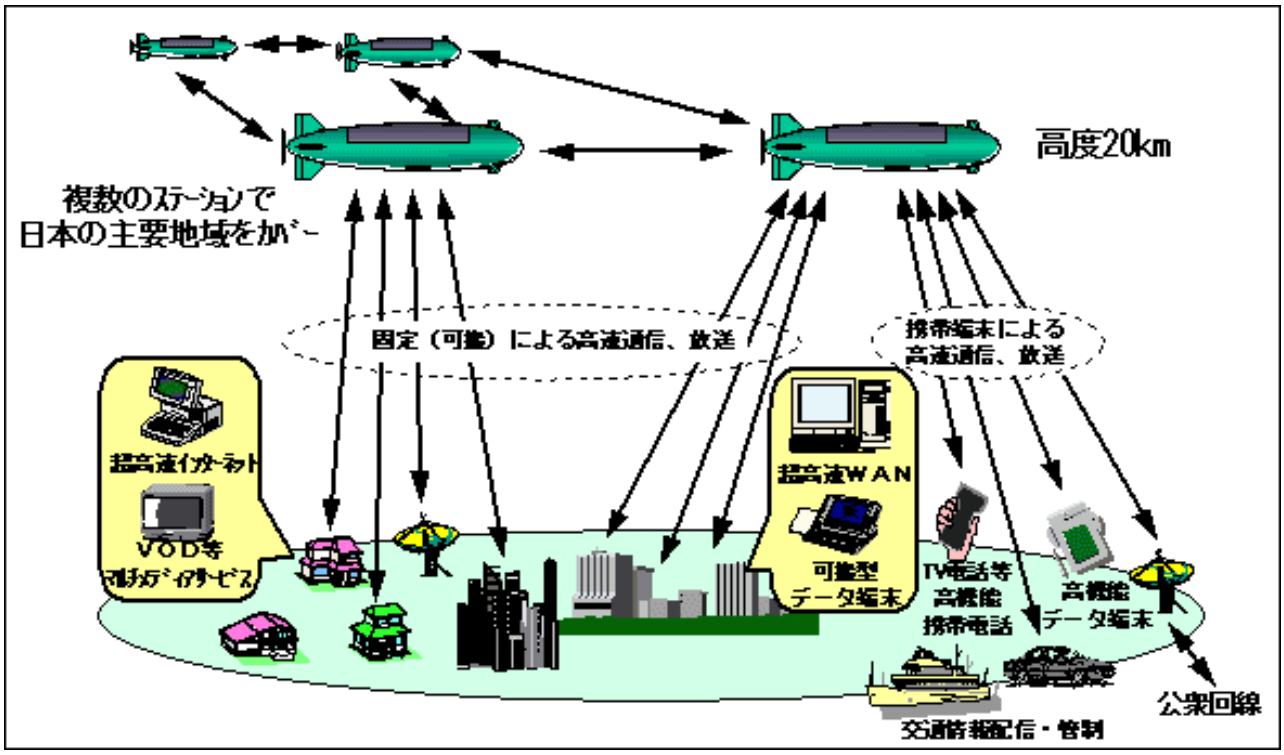




p32　Principal Investigator, Yoichi MOTOYOSHI



p42　Principal Investigator, Hiroshi L. Tanaka



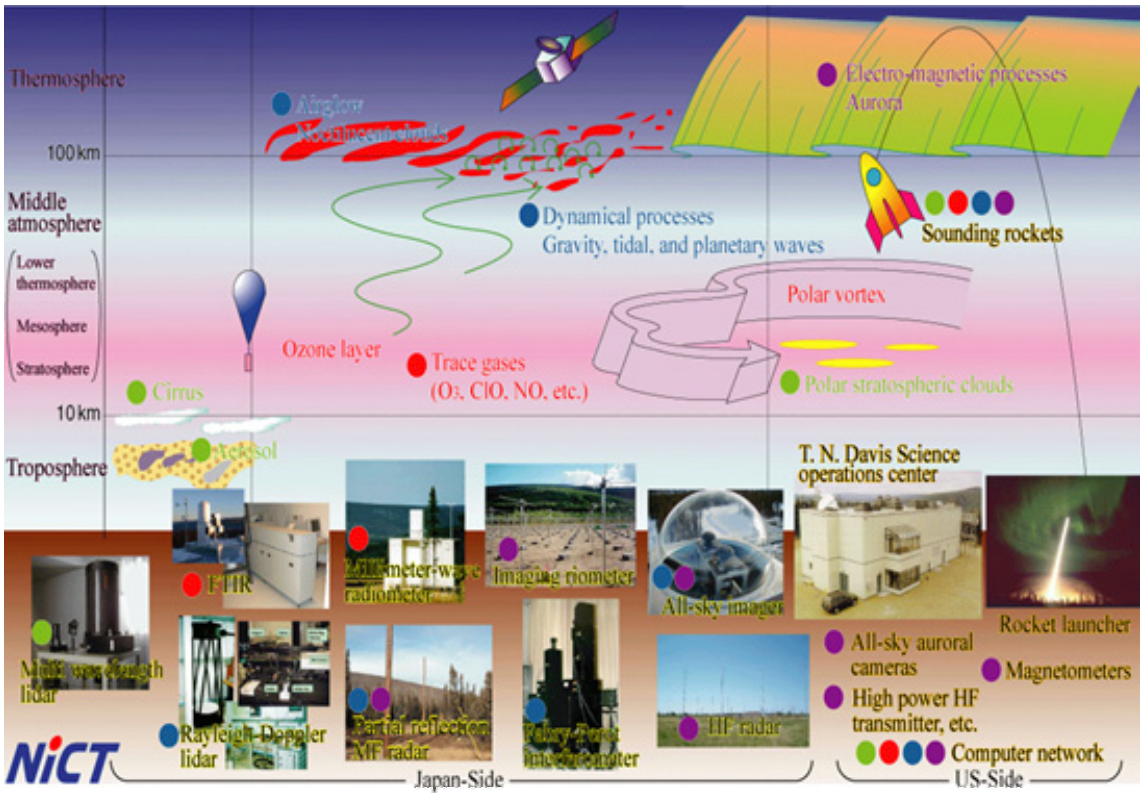


Figure 1. Observation instruments for our project and their targets.

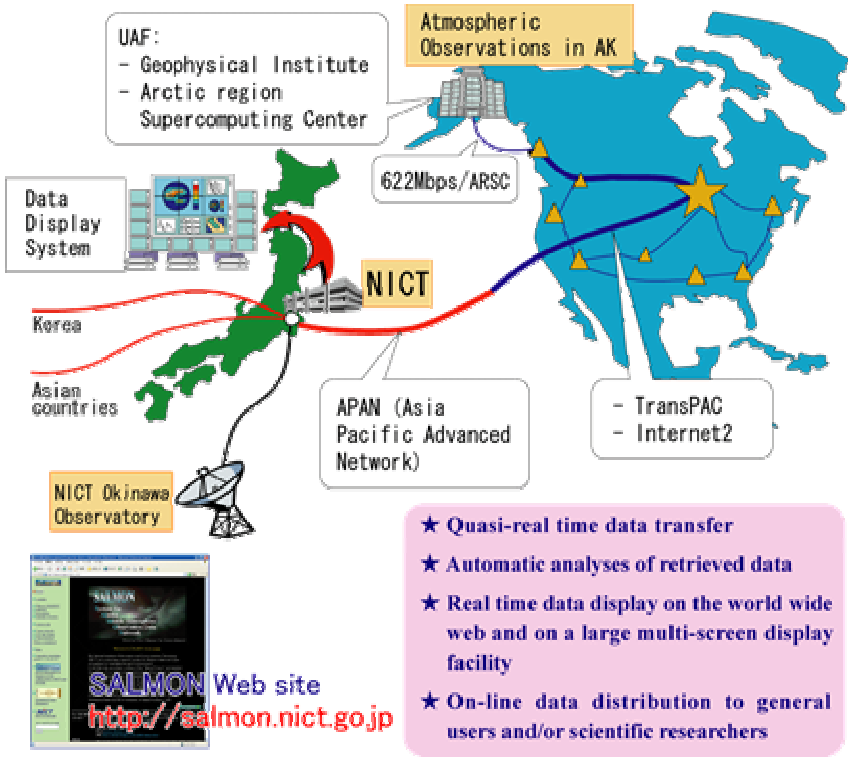


Figure 2. International high-speed computer links for the data network system SALMON.

p46　Principal Investigator, Shuhei TAKAHASHI

Fig. 1
McCall Glacier in Brooks Range, Alaska

p47-48　Principal Investigator, Shuhei TAKAHASHI

Fig. 1 Investigation area
in Eastern Siberia

Fig.2
No.31 Glacier in Suntar-Khayata