2009

National Annual Report on Polar Program of China

Chinese Arctic and Antarctic Administration (CAA)
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Mr. Sun Zhihui,
Administrator of SOA

Foreword

2009 was a remarkable year in the history of China's Antarctic expedition. As a result of tremendous efforts and hard working, the first Chinese inland Antarctic station on the ice sheet--the Kunlun Station was successfully established on Dome A where the elevation is more than 4000 meters above the sea level. It is a great leap forward for China in advancing its Antarctic expedition from the area along the coast to the hinterland area of the Antarctic continent.

With the full-scale implementation of the polar program capacity building projects during the Tenth Five-year Plan, China's capacity in logistic support has been improved greatly; the implementation of China's Action Plan for the International Polar Year has further extended its studying

scope in polar scientific research; the active participation in international polar affairs and close cooperation and exchange in scientific research has raised its role and status in international polar community and polar scientific research; visible progress has been made in polar strategic study and the work on planning of the polar scientifc research; the in-depth polar scientific research has achieved a series of remarkable results; in addition to the above, the public education on polar science has witnessed good effect.

The year of 2009 is the 25th anniversary of China`s Antarctic expedition, 20th anniversary of the establishment of the Zhongshan Station, 10th anniversary of China`s Arctic expedition, 5th anniversary of the establishment of the Yellow River Station, 20th anniversary of the founding of the China's Polar Research Center, and it is also the 50th anniversary for the Antarctic Treaty to be openned for signature. With so much historic significance, this year has put a great deal of expectation to the progress and success for Chinese polar scientific exploration and research, and the Chinese polar scientists have bravely undertaken such historic responsibilities and carried out a series of Antarctic programs and achieved remarkable progress and success in the year of the 60th anniversary of the founding of the People`s Republic of China.

The Chinese Government has shown great concern to the Chinese Antarctic cause; the Chinese Antarctic research programs have received full support from the related departments of the central government; our polar programs have been proceeding in a sound way of close cooperation among the scientific institutes and universities, and the Chinese people have paid much attention to our progress and success.

Presindent Hu Jintao sent a message to the Kunlun Station located on Dome A in the East Antarctic continent in congratulation of its completion, and Vice Premiere Li Keqiang delivered a speech and made important comments and instructions regarding our Antarctic expeditions and research at the meeting in commemoration

of the 25th anniversary of the Chinese Antarctic expedition. All these have shown sincere concern to the Antarctic expeditioners and input a great driving force to the Chinese Antarctic cause.

The year of 2009 has passed. It is necessary for us to sum up the experience and successes achieved in the year, to draw a long term comprehensive Antarctic plan based on the scientific concept of development and better understanding of the international development in Antarctic research, so that we can enhance our scientific research ability, to achieve even greater progress and turn a new page for China's Polar scientific research activities.

Sun Zhihui

Administrator of SOA

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I. The Summary of the Polar Program in 2009

The Summery of the Polar Program in 2009

China's Polar scientific activity in 2009 was based on three objectives: the construction of the Kunlun Station, the capacity building for Polar program during the Tenth Five-Year Plan and the implementation of China's Action Plan for the International Polar Year.

The priorities and direction of the work of 2009 Polar program was put on the area of the Zhongshan Station and the construction of the Kunlun Station on Dome A. The first priority according to the national Antarctic program is to make sure that the Kunlun Station be set up in time, so that our efforts were concentrated on the needs for the construction of the Kulun Station, such as team organization, installations and equipment and materials preparation. Based on these efforts, the main construction of the Kunlun Station was completed in time, which was a milestone for China's Antarctic Program in the year of 2009.

In addition to the construction of the Kunlun Station, the 25th China Antarctic Scientific Expedition and the 2009 Arctic Scientific Program at the Yellow River Station were carried out

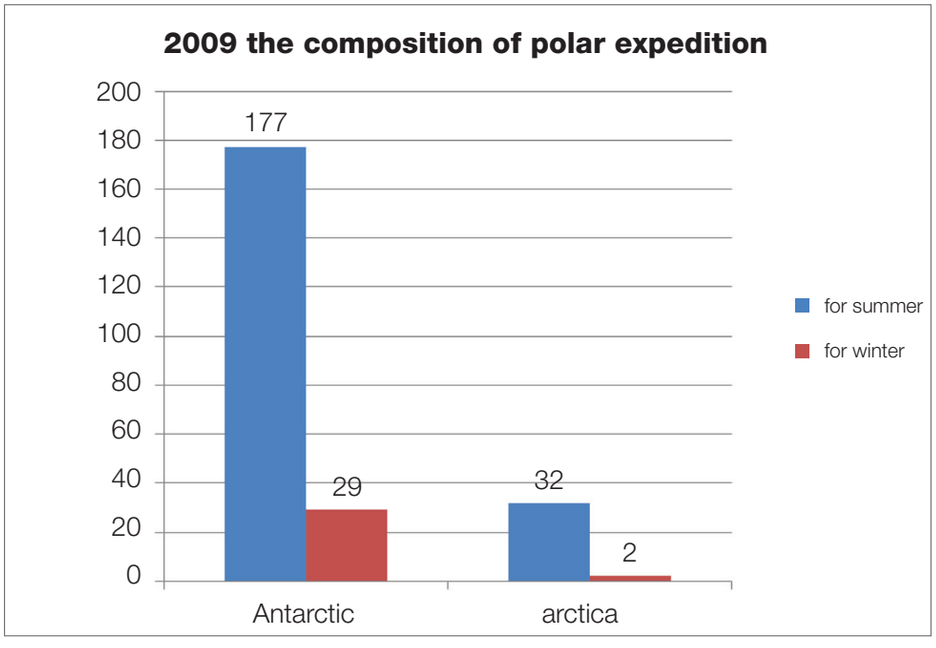
as planned; China's Action Plan for the International Polar Year has been put into full implementation and visible progress had been made; the upgrading and renovation of the Great Wall Station were finalized and the basic engineering for such upgrading and renovation in the Zhongshan Station was conducted as planned and the development of a long term plan for our Polar scientific programs during the period of the 12th Five Year Plan has been initiated.

The detailed implementation of the Polar program is given as follows.

(I) The Antarctic Program

1.Total number of personnel involved

The total number of the persons who participated in the Antarctic expedition was 234, among whom 28 worked at the Kunlun Station, 55 worked at the Great Wall Station with 43 for summering and 12 for wintering; 70 persons worked at the Zhongshan Station with 53 for summering and 17 for wintering; 16 researchers and 40 crew participated in the Southern Ocean exploration, served by



a 25-member- management and logistic support team.

2. The implementation of the programs

The construction of the main building of the Kunlun Station covers an area of 236 m^2, which consists of a research quarter and a living quarter; a 50m × 4000m runway was cleared for small aircraft; the installing of the antenna for short wave communication, the antenna for Iridium satellite communication and the aviation HF radio antenna were all completed; besides, the surveying and mapping on the scale of 1:5000 for the station area was made. I addition to the above, an ice core of 63m long was obtained; checking and maintenance for Plato and CSTAR observation systems as well as for the earthquake auto-observation system was carried out; high-precision GPS measurements for 10 points was done; blood-sampling and heart function tests for the expeditioners were carried out.

Glaciological survey was carried out along the route from the Zhongshan Station to Dome A. The ice drilling was done and a 90 m ice core has been obtained at a point 800 km from the Zhongshan Station; GPS positioning of the surveying poles marking the ice movement erected every 2 km was conducted and the measurements of the elevations of the poles were also done; measurement of the 4 pole grids for ice movement set up during the 15th expedition were done; the surface snow sampling at every 10 km and the measurements of snow temperature and density on the surface and at the depth of 15 cm at every 10 km were conducted; besides, snow samples were taken from 3 3m deep snow pits. 10 GPS surveying points for high-precision measurement has been established, 3 magnetometers and 4 earthquake observing systems were set up.

3. China's Action Plan for the International Polar Year (IPY)

The implementation of China's Action Plan for the International Polar Year is one of the key parts of the Antarctic program for 2009. A total of 48 projects were carried out in this austral year, among which 9 projects were carried out at the Great

Wall Station (5 projects were related to IPY), 19 projects were carried out at the Zhongshan Station (13 projects were related to IPY); 13 projects were carried out in the Southern Ocean (all related to IPY), 3 projects were carried out on inland ice sheet (2 projects were related to IPY) and 2 projects involved international cooperation.

At the Great Wall Station, apart from the routine meteorological observation projects and the continuation of 4 observation projects such as the observation at the unattended tracking station and the International GPS Campaign, ionospheric observation in the Antarctic area, upgrading of the earthquake stations and microseismic observation, and near-shore marine environmental monitoring system, five new science programs related to IPY were conducted, such as: surveying of the photo control points at the Great Wall Station area; surveying and mapping at scale of 1:500 at the Great Wall Station; study on the ecological evolution at the Great Wall Station area; biological study on bio-diversity over Fildes Peninsula and study on the test of biological clock gene and detection of biological rhythms of the Antarctic expeditioners.

At the Zhongshan Station, in addition to continuation of some routine observation programs such as meteorology observation, satellite remote sensing and ozone observation, upper atmospheric physics observation, geomagnetic observations, earth tide, tidal observation and GPS tracking,13 new IPY projects were added, among which 11 projects were for the austral summer season: the establishment of gravimetric datums in the Zhongshan Station; the function expansion and array construction of the satellite monitoring station; C, N, S, P circulation study at the Zhongshan Station; SLF/ELF atmospheric noise measurement and analysis; deployment of sea ice monitoring buoys and the observation of sea ice mass balance in Prydz Bay; field experiment of the structure of Katabatic wind; the physiological and psychological impact on the expeditioners of the environment at the Zhongshan Station; study on dynamics of Dalk Glacier and the monitoring study on some typical lakes in Larsemann Hills; geological survey of the Amery Ice Shelf; observation of atmospheric ozone; and study on the biological clock gene and detection on biological rhythms of the Antarctic expeditioners. Two projects carried out during the winter time were: study on the relations between the Antarctic ice thermodynamic processes and hydrological and meteorological conditions; atmospheric environment monitoring in the Zhongshan Station area.

There were 15 oceanographic research projects carried out during the

voyage from Shanghai to the Antarctic. The projects were: underway XBT/XCTD oceanographic measurements; study on the structure of the micro phytoplankton community and the study on marine biodiversity; aerosol samples collection; study on the carbon flux in the Southern Ocean jointly conducted by the scientists from both China and the US; study on the distribution of N_2O source/sink and the flux of the air-sea exchanges in the Southern Ocean; new productivity survey in Prydz Bay; study on isotope ocean chemistry; Southern Ocean front processes and the current circulation in Prydz Bay; study on persistent organic pollutants on the route to the Antarctica by R/V XueLong; aerial observation of Amery Ice Shelf polynias; physical oceanography observation in Prydz Bay; submarine profile oceanographic measurement by an auto-ascending and descending system; study on the monitoring and evaluation technology for marine biological resources and ecological process; study on the South Ocean carbon biological geochemistry and study on the collection and isolation of microorganism in the Antarctic region.

(II) The Arctic Programs

1. Total number of personnel involved

The total number of persons participating in the Arctic Expedition was 34, among whom 32 were for summering and 2 for wintering at the station.

2. The programs conducted

There were 12 scientific projects accomplished in 2009 at the Yellow River Station in the Arctic. The scientific activities were mainly focused on environmental monitoring, climate study, glacier study, bio-ecology study and upper atmospheric physics study. The projects were: study on the methods of analysis and verification for heavy metal organic pollutants in multiple environmental mediums; study on the temporal/spatial variation of Arctic tundra greenhouse gases flux in Ny-Ålesund region in Arctic and their influencing factors; study on geomicrobiology of mine drainage in Svalbard region and its geological and environmental effect; collection of sediment at the Yellow River Station

for fecal mercaptan ^{13}C analysis; study on distribution and sedimentary dynamics of modern foraminifera at Kongsfjorden near the Yellow River Station; investigation and utilization of active peptide gene resource of toxic animal species in the Arctic; ecological monitoring in the Yellow River Station; observational studies over Arctic tundra for its physical process near ground; monitoring of the correlationship between modern glaciers and climate change in the Svalbard region; observation of the ionospheric layer at the Yellow River Station; study of summer time Arctic sea smoke. In addition to the above, renovation has been done to the existing wired remote sensing automatic meteorological observation tower; a 10-meter meteorological observation tower has been installed, in whichVAISLACo, the instrument made in Finland were adopted for measurement of wind speed and wind direction; for atmospheric temperature, pressure and humidity measurement, an Australia-made DT – 500 data collector was fixed for data collection and storage; a new cosmic noise receiver for ionosphere observation has been installed and tested in a Sino-British joint project.

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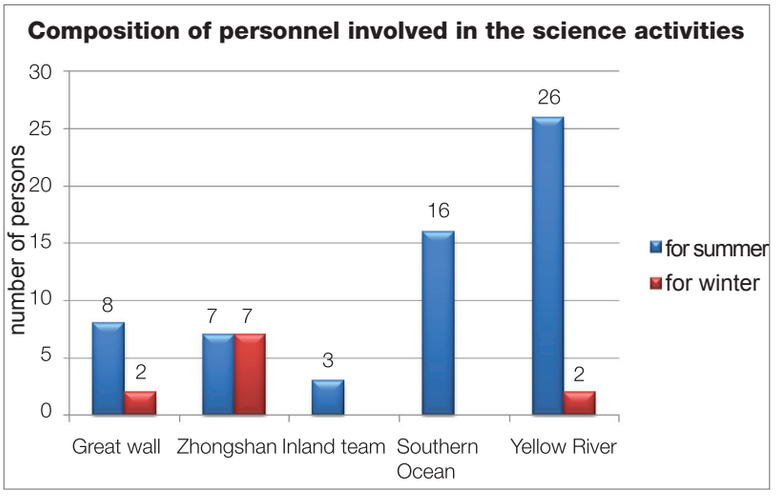
II. The implementation of the Polar programs of 2009

The implementation of the Polar programs of 2009

(I) Highlights of the Implementation Plan

1. The 25th Antarctic Expedition of 2009 and the Arctic Yellow River Expedition of 2008 were conducted. During the 25th Antarctic Expedition 34 science projects were carried out and routine observation projects for both the Great Wall Station and the Zhongshan Station were continued; 11 science projects were carried out at the Yellow River Station.

2. Composition of personnel involved in the science activities.



(II) Implementation of the programs at the stations

1. The Great Wall Station

(1) Surveying of photo control points at the Great Wall Station and its circumjacent area; updating the 1:500 topographic map of the station area.

More than 190 control points were measured; one GPS point was remeasured; field survey was conducted for 100 odd detail points; geographical information products for the Great Wall Station and its circumjacent area were made on various scales including digital orthophoto maps (DOM), digital elevation models (DEM), digital line graphics (DLG) and digital raster graphics (DRG) .

(2) GPS tracking station and international GPS Campaign at the Great Wall Station

Continuous GPS observation data were received for 69 days; 3M of original data and 4M of data in renix format were received each day; the total amount of data received was about 490M.

(3) Maintenance and modification of the seismic station at the Great Wall Station

5.71 G of real-time earthquake data were recorded for 353 days .

(4) Study on the evolution of eco-environment in the Great Wall Station

For biological study, the following samples were collected: 280 bags of air sample were collected on Ardley Island; 220 vacuum flasks of air sample were collected in the area of the Biological Bay; 10 bags of Tedlar gas samples and 40 bags of soil samples were collected.

(5) Eco-environmental monitoring on Fildes Peninsula

For analysis of chlorophyll and nutrients, oceanographic investigation was conducted over 10 stations in the Great Wall Bay, profile data of temperature and salinity in <20m water column and the data of dissolved oxygen in <10m of water column were obtained.

2. The Zhongshan Station

(1) Routine meteorological observation

The primary items of weather ob-

servation at the Zhongshan Station were mainly routine meteorological observation, reception of the weather fax data and sea ice observation. CAWS600 weather observation system has been updated; overall maintenance has been carried out on routine equipment; and meteorological telegraph were sent to Davis Station at stipulated time according to the requirement.

(2) Ozone observation

According to the ozone observation guidelines, the total ozone, SO_2, N_2O and UVB radiation were monitored using Brewer ozone detector. The measured data were sent to China Academy of Meteorological Sciences and the World Meteorological Organization (WMO). 35M of data was collected in all.

(3) Geomagnetic and spatial environment observation

Digital recorder collected geomagnetic data in three components every day; 1.5G of data were collected; GPS ionospheric recorder collected 5.3M of data, the total of data was about 1.8G.

(4) Sino-Japanese joint study on upper atmospheric physics

Optical observations were conducted for 112 days in 2008; 1300 hours of aurora data was recorded; besides, routine maintenance of the observation equipment was carried out; the inductive magnetometer was calibrated and updated; altimeter radar was relocated; and relavent documents were submitted.

(5) Earth tide observation

LaCoste-Romburg gravimeter was adopted for earth tide observation. The observing time lasted for 339 days and 779 M data were collected.

(6) GPS tracking observation and perennial tide data acquisition

A set of Lecia GPS-GRX1200Pro and auxiliary equipment was added to the original GPS tracking station so that two sets of GPS satellite systems can be simultaneously operated, greatly improving the positioning function and the observation software system has been upgraded.

(7) SLF/ELF air noise measurement and analysis

The observation data was obtained on a monthly basis and continuous SLF/ELF air noise measuring data was obtained in persistent manner.

(8) Upgrading of the satellite stations in the Zhongshan station

The operation house for satellite station was reconstructed, and the satellite system was relocated and recalibrated.

(9) Establishment of the gravimetric datums

The observation post for absolute gravity measurement was in place and calibration for relative gravimeter measurement was completed.

(10) Study on physiological and psychological impact on the Antarctic expeditioners

The study is focused on the impact caused by different environmental factors on the neurohumoral-endocrine-immune network of the Antarctic expeditioners

(11) Dalk Glacier dynamics study and the monitoring of some typical lakes in Larsemann Hills

The purpose of the study is to measure the movement speed of the crevices at the lower reaches on the Dalk Glacier and the movement speed of the glacier at the summer time. The curve representing the changes of the water levels in 6 lakes in Larsemann Hills and the water samples from the 6 lakes were collected during summer time.

(12) Geological survey on Amery Ice Shelf

GPS locations of 2 control points on the outcrop of the bedrock and 8 observing points on the ice shelf were precisely measured; measurements were done over 8 poles marking the balance of the surface mass on the Ice Shelf .

(13) Impacts of different environmental on psychology of the expeditioners

Expeditioners were examined to obtain physical phenotype parameters, such as the impacts of different environmental factors on the functioning of vital organs systems, namely the heart, brain, lungs and the blood system; on the changes of neurohumoral-endocrine-immune regulative net; and on gene expressions.

(14) Observations of the structure of Katabatic wind

A wind detecting Doppler radar was fixed in the Zhongshan Station to continuously measure 3 dimensional wind-fields for 40 days, nearly 40 million sets of pulse data, 800, 000 sets of radiation data and 800,000 sets of gradient data were obtained.

(15) Study on the biological clock gene and biological rhythms of the wintering expeditioners

Examination results indicate that all eight expeditioners show marked day/night biological rhythms and demonstrate physiological mechanism adapting to the Antarctic day/night.

(16) On-line observation of atmospheric composition

Greenhouse gas sampling system, vertical profiling ozone detector and on-line atmospheric composition observing system were used to detect atmospheric structure, the ratio for data acquisition was in 99% during the operation.

(17) Deployment of sea ice measuring buoys and sea surface mass balance monitoring in Prydz Bay

During XueLong's voyage, sea surface temperature was measured for 25 days and complete record data were obtained, including original data relating to relevant time, place and temperature.

(18) Study on C, N, S, P circulation in the Zhongshan Station

NO_2、SO_2、O_3 were monitored using multiaxial passive differential absorption spectrometer during the voyage, the distribution and concentration of the three gases were observed.

3. Inland investigation on the ice sheet

The field team set out from the Zhongshan Station on Dec.18, 2008 and came back from the Kunlun Station to the Zhongshan Station on Feb. 23, 2009. The field investigation for PANDA (IPY) core program was conducted during the field trip. The scientific activities carried out at the Kunlun Station were: taking 63 meters of ice core through ice drilling; maintenance of astronomical observation system (Plato /CSTAR) was carried out; precise GPS positioning survey over 10 points was done; taking blood samples from the

■ *Inland expedition to Kunlun Station on the ice sheet*

expeditioners for medical research; cardiac function test on the expeditioners. The scientific activities carried out on the way from the Zhongshan to Dome A or on the way back from the Kunlun Station to the Zhongshan Station were: 90m of ice core was taken through ice drilling; GPS position calibration and height meaesurement of poles marking ice mass movement; measurement of the 4 pole grids for ice mass balance; surface snow sampling; snow surface temperature and density measurement; establishment of 10 points for high-precision GPS measurement; installing 3 magnetometers and 4 automatic earthquake observatory systems. The inland team accomplished all these activities.

4. Oceanographic Investigation

The vessel Xuelong took a new navigation route, i.e. from the Zhongshan Station - Melbourne port - Casey Station- the Zhongshan Station. The vessel sailed through the west wind belt twice at different longitude and conducted multi-disciplinary investigations such as surface

temperature and salanity measurement by XBT/XCTD and sample collection for biological chemistry, and atmospheric studies.

PANDA program was also incorporated in the oceanographic field investigation, such as profile measurement for marine parameters, sea ice and air in the west wind belt, Prydz Bay, and the coast area close to Amery Ice shelf. The multidisciplinary investigations included: physical oceanography, oceanographic chemistry, marine biology, marine geology and some other integrated observations. Surveys of 5 profiles were conducted, in which data and samples were obtained on physical oceanography, marine biology and marine chemistry. Bottom mud samples and suspended water samples were collected at the depths of 3100m in the Southern ocean. In these samplings, large volume water samplers with 24 water bottles were used, and temperature, salinity and depths were measured at the same time.

5. The Yellow River Station

(1) Ionospheric observation

TEC observation system was adopted to conduct ionospheric scintillation observation, and the observation data was collected from May 6 to 13.

(2) Monitoring study on co-relations between modern glacier and climate change in Svalbard region

Nine poles were erected for mass

balance monitoring; 26 GPS benchmarking poles were re-measured on Austre Lovénbreen and Pedersenbreen glaciers; snow samples were taken from the snow pits on Austre Lovénbreen glacier and 20 sets of surface fresh snow samples were collected along the direction of mainstream line of the Glacier.

(3) Study on the inter-relations between the plant diversity and environmental changes

Plants were collected from eight investigated sites and specimens of twenty-eight plant species were made and pollen of these plant species were collected. Four surface sedimentary samples were taken from a Quaternary sediment profile for glacier sedimentary environment analysis under a joint program with Norway University of Life Sciences. For modern sedimentary environment study, ten soil samples were taken from London Island and five soil samples were taken for pollen analysis. Three sedimentary columns were collected from the Bird Cliff used to study the inherent relationship between the plant diversity and environmental change..

(4) Eco-geological investigation in ice-free area at the Yellow Rive Station

Field investigation was conducted as below: 8 sedimentary column samples were taken; 5 surface sediment samples were collected from lakes; 10 samples of animal residues and marine animal guano were collected; 58 samples of tundra vegetation and 58 soil samples were taken; 600 bottles of air samples were collected; 94 soil samples and 42 marine surface sediment samples were collected.

(5) Phylogenetic diversity of bacterioplackton and its ecological functions in Kongsfjorden

5 water samples were collected from both the surface and bottom, 3 samples from surface sedimentary deposit were collected for comparative study of diversity between culturable and unculturable bacteria.

(6) Study on modern sedimentary dynamics and sensitive climate record.

Two pieces of petrified wood were collected; two glacial erratics from the

Bird Island were collected; 45 samples of surface sediment were collected; 4 samples of surface sediment- reflecting human activities were collected; 3 short sedimentary rock cores were taken and 80 tundra plants samples were collected. These samples would be used for analyzing the information of the late Quaternary paleoclimate and paleoenvironment.

(7) Study on the distribution characteristics and releasing flux of phosphine in Spitsbergen region

For the purpose of studying releasing flux of phosphine in wetland, medium wetland, dry land, sea surface-atmosphere and coal mining ground-atmosphere, the following samples were collected: 19 soil samples, 7 sediment samples from lakes, 20 samples of marine sediment, 13 vegetation samples and 17 air samples.

(8) Atmospheric environment monitoring and evaluation in Svalbard area

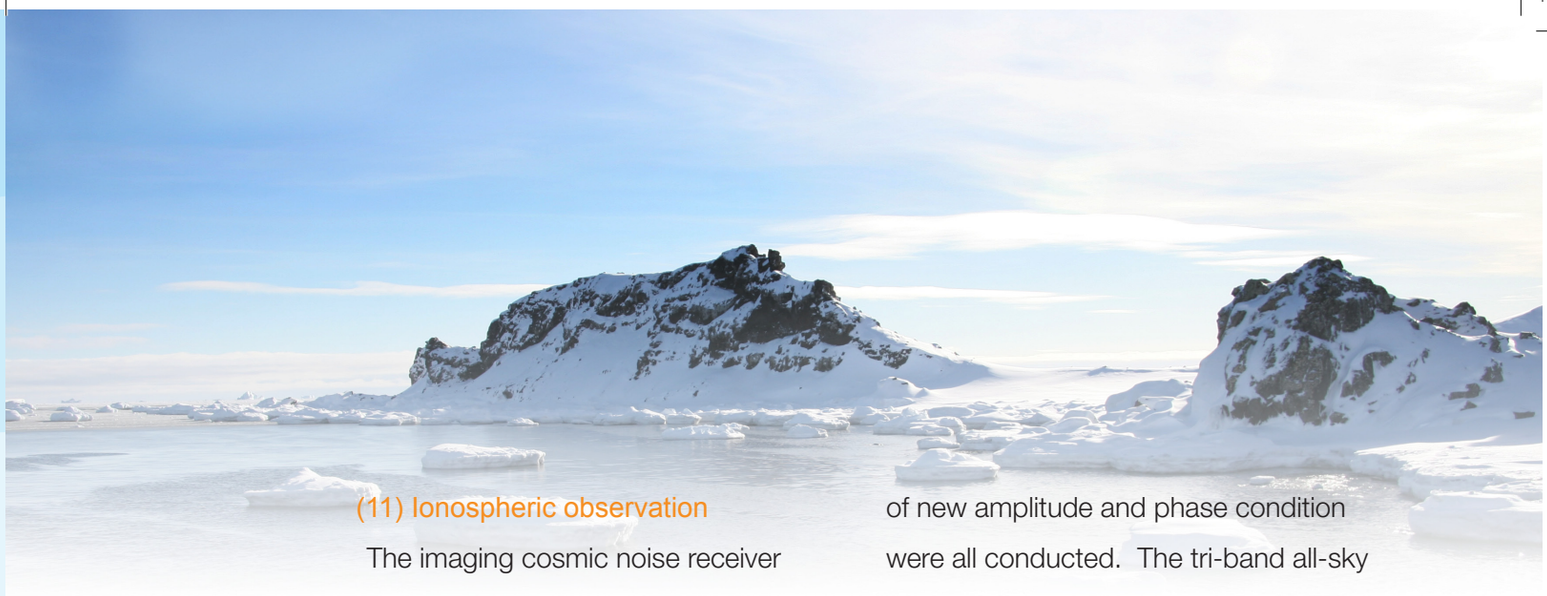
In order to carry out the project, the following samples were collected during field investigation; 18 inorganic and organic aerosol samples; 3600 sets of carbon black concentration data through continuous observation; 30 atmosphere samples containing nitric oxide and methane; some samples of persistent organic pollutants and heavy metal; 1 sedimentary column sample from a lake; and 38 marine surface sediment samples. In addition, some moss and soil samples were collected.

(9) Eco-environment monitoring at the Yellow River Station

Regular investigation of five profiles was conducted. Oceanographic parameters of temperature, salanity and depth were measured at different positions; 47 seawater samples were collected; space distribution of biodiversity was carried out on a micro scale; field microbial counting was done; 47 sample of chlorophyll a, POC and pigments were collected respectively; 39 plants samples were collected; 10 soil samples for cultivating actinomyces and 10 water samples from the lakes for algae cultivation were collected and 22 samples were taken from the surface sedimentary deposit in the Bay.

(10) Study on boundary layer physical process in tundra area

Inspection and maintenance was conducted of the automatic weather Stations; data downloading was done and the reliability of data was confirmed. The antenna array for observing cosmic noise has been installed and routine meteorological observation data from July 2007 to October 2008 was obtained.



(11) Ionospheric observation

The imaging cosmic noise receiver has been upgraded; the tri-band whole sky aurora imaging system has been upgraded; the ionosphere scintillation/ TEC observation network has been constructed; real-time data transmission test, analysis of the original data, establishment of new amplitude and phase condition were all conducted. The tri-band all-sky aurora CCD imaging system was adopted to conduct aurora observation. While conducting observation, the real-time solar wind ACE satellite data was combined to record all space events that happened during observation of aurora.

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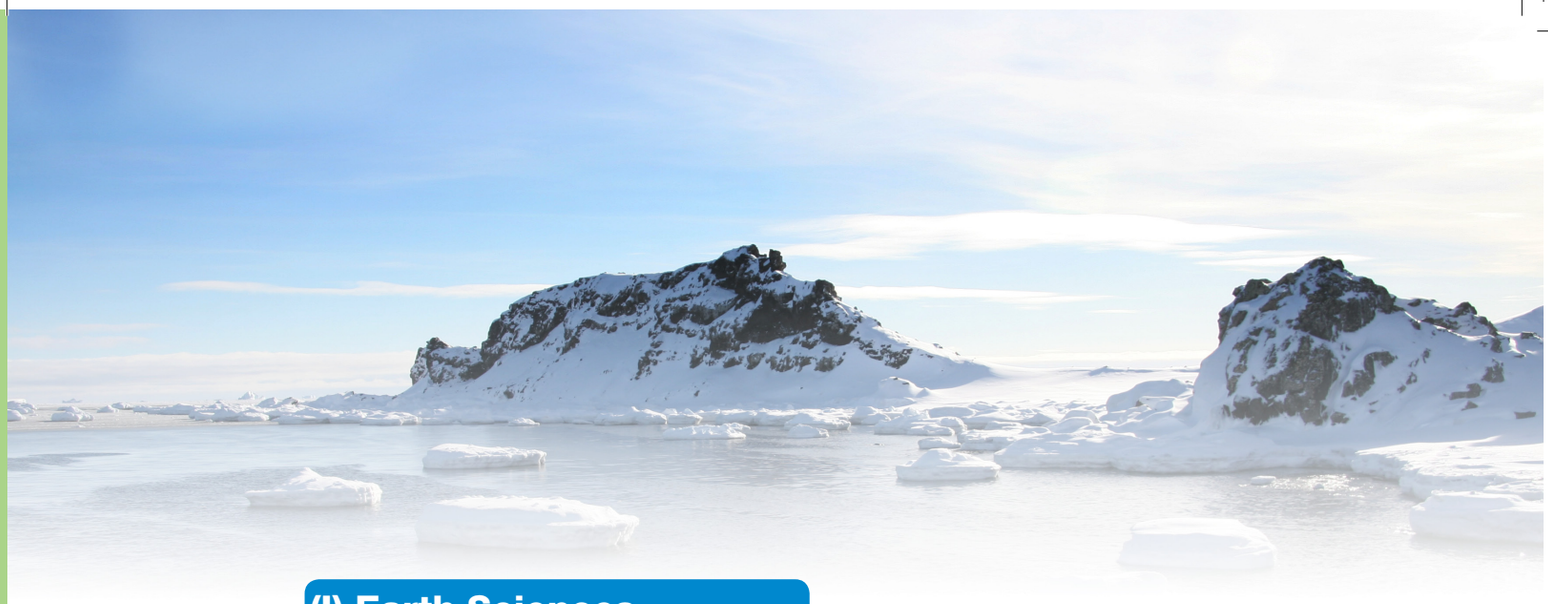
III. Progress and Achievements of the Programs



(I) Earth Sciences

1. Compiling and publishing of the Antarctic and Arctic atlas

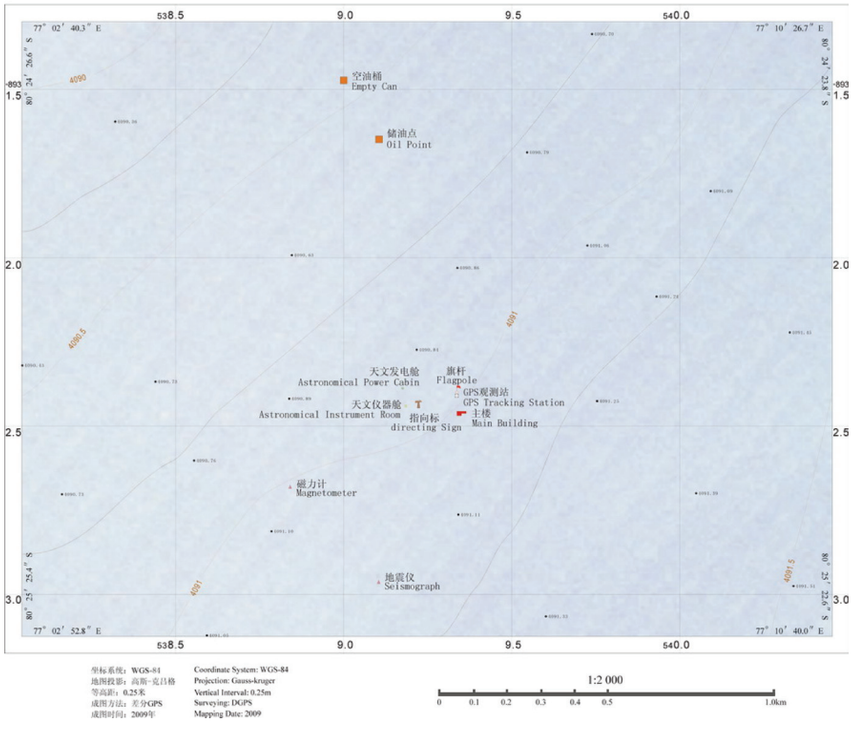
The Chinese Antarcric Center of Surveying and Mapping of Wuhan University and the Key Laboratory of the State Bureau of Surveying and Mapping for Polar Surveying and Mapping Science published a polar atlas (“hereinafter referred to as”the atlas “) under the supervision of China Arctic and Antarctic Administration. It is the first atlas in China representing the national achievements in the Antarctic and Arctic surveying and mapping. Based on relevant domestic and foreign information, the atlas collected 36 ordinary geographical maps, 15 thematic maps, 22 image geographic maps, 150 pictures and 22 ,000 words for description. It is a collction of atlas reflecting the progress of China in surveying and mapping during the last 25 years. The atlas of colored maps has used the desktop publishing system of digital mapping technology to realize the integration of the maps.

■ *Publications of the Antarctic and Arctic atlas*

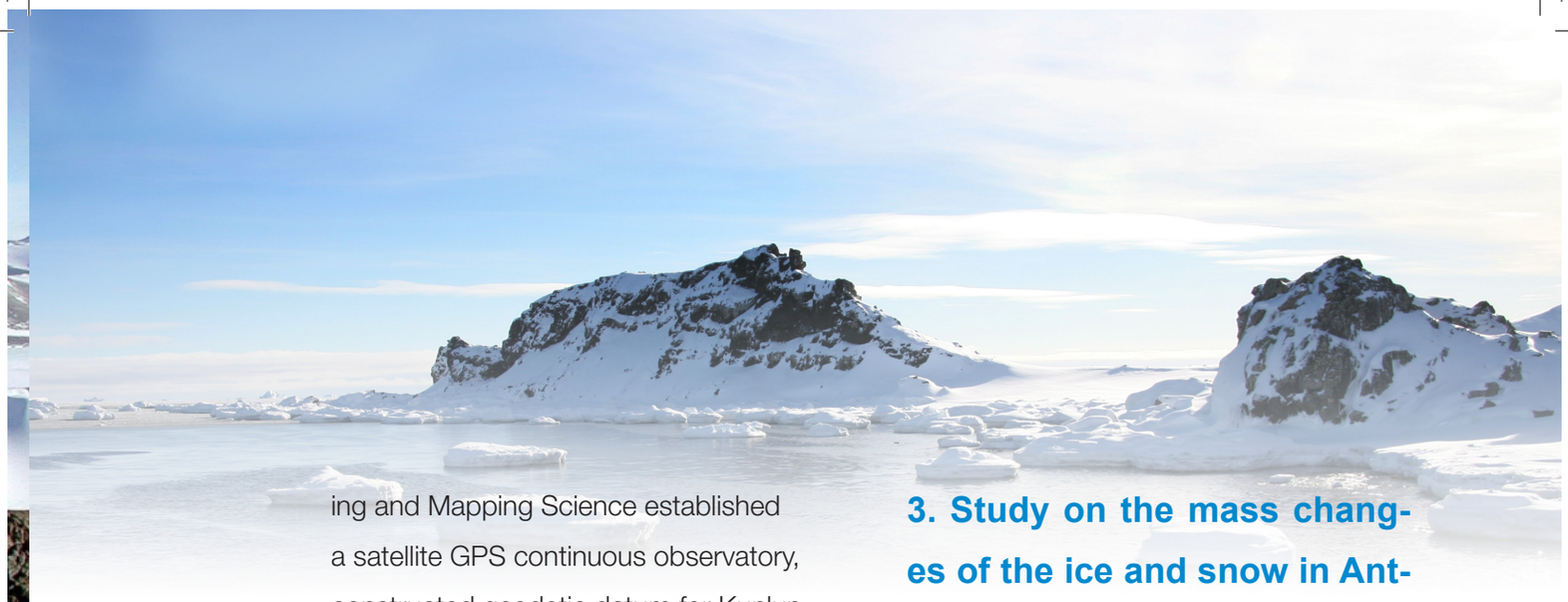
2. The topographic surveying and mapping and monitoring of ice streams at the Kunlun Station

Starting from January 2009, the Key Laboratory of the State Bureau of Surveying and Mapping for Polar Survey-

Kunlun Zhan



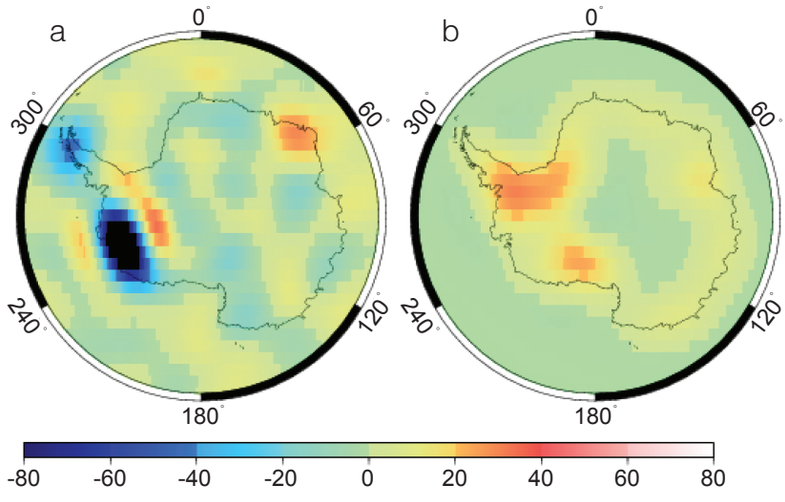
■ *Topographic map of the Kunlun Station at the scale of 1:2000*



ing and Mapping Science established a satellite GPS continuous observatory, constructed geodetic datum for Kunlun Station area, with the real-time dynamic differential GPS satellite positioning technologies (RTK surveying and mapping), completed the topographic maps for the Kunlun Station area at 1:5000 and 1:2000 large scales. GPS technology was also used for monitoring 10 ice streams, which accumulated a large volume of field data on the dynamic process of snow and ice on the the highest Antarctic ice sheet.

3. Study on the mass changes of the ice and snow in Antarctica by using the satellite gravity field data

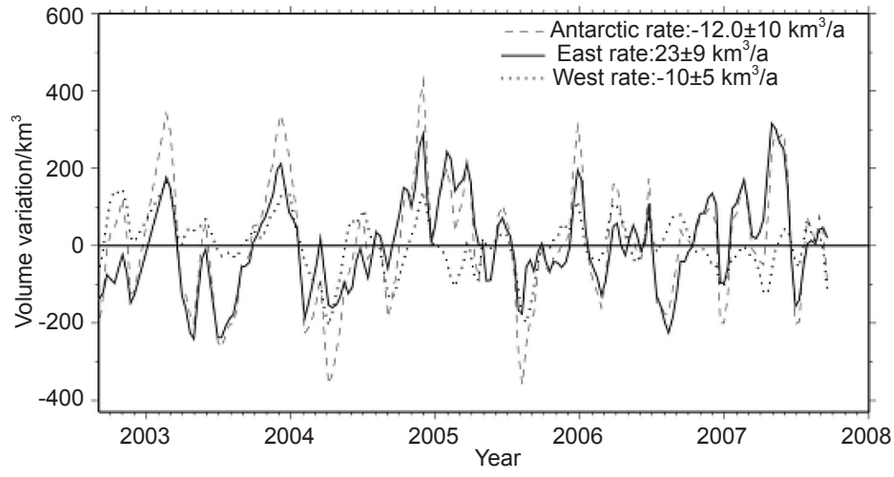
During the 25th Antarctic scientific expedition, the Key Laboratory of the State Bureau of Surveying and Mapping for Polar Surveying and Mapping Science conducted measurements for three absolute gravity spots using A10 portable absolute gravimeter. The time-varying gravity data from GRACE satellite during the last



■ *Mass changes of the ice distribution in Antarctica*

(a)after deducting the impact of post glacial rebound (b)with the impact of post glacial rebound

(b)the equivalent volume changes of the Antarcitic ice sheet



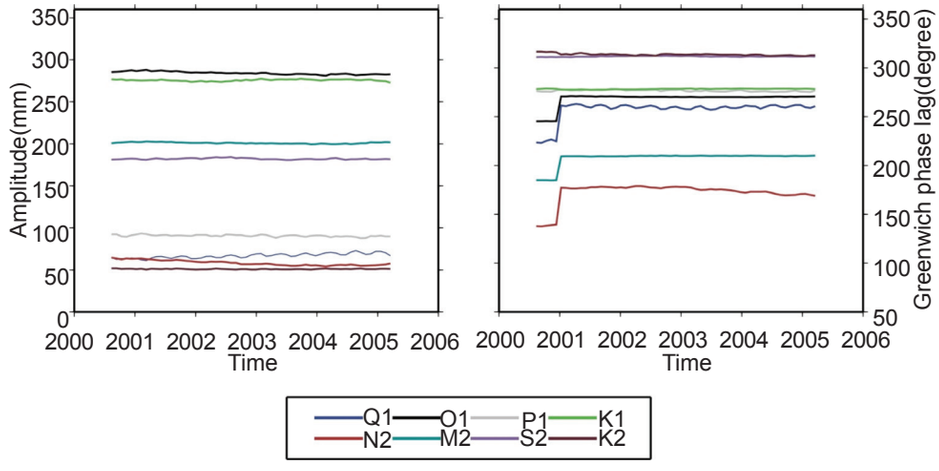
■ *(a)East Antarctic (b)West Antarctica (c)whole Antarctica*

5 years showed that significant decline has appeared in the southwest of the Amundsen region; ice and snow quantity has been on the decline on the Antarctic Peninsula; but the ice and snow increased in Enderby Land of east Antarctica.

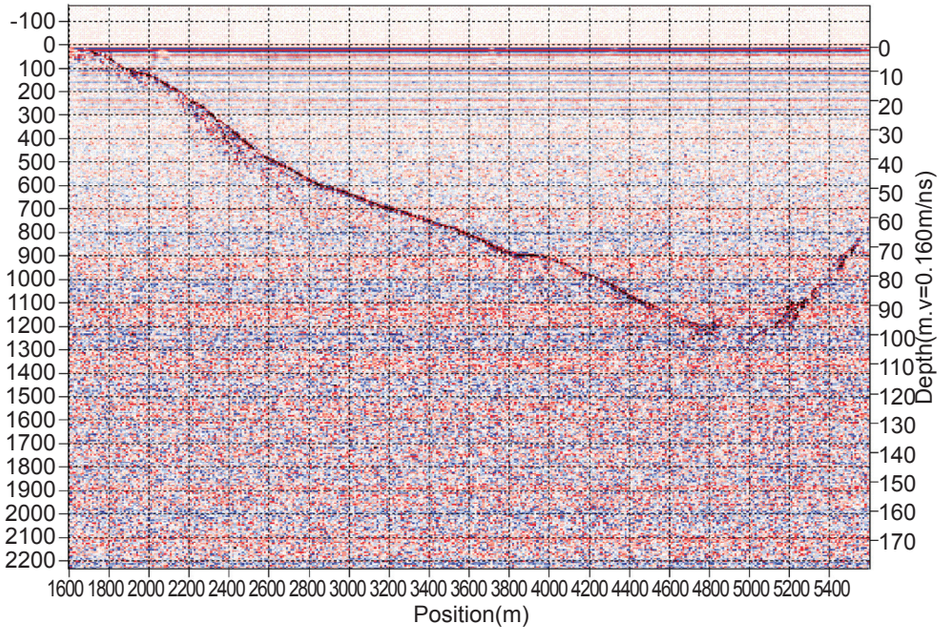
After deducting the impact of post glacial rebound using ICE5G model, according to the caculation done during July to September, 2007 the equivalent volume changes of the ice sheets in whole Antarctica, East antarctica and West Antarctica are respectively: -78±37km^3/a, -3±46 km^3/a and -75±50 km^3/a; corresponding sea-level changes contribution of 0.21 ± 0.1 mm/a, 0.008 ± 0.127 mm/a and 0.2±0.14 mm/a. It is also found that the post glacial rebound model of the ice caps is the key factor to be studied for the mass changes of the ice sheet.

4. Study on the tidal characteristics of the Zhongshan Station

The Key Laboratory of the State Bu-



■ *Eight curves representing the Changes of the harmonic constant of sub-tides with the time*



■ *Depth detecting profile of the Austre Lovénbreen Glacier in the Arctic*

reau of Surveying and Mapping for Polar Surveying and Mapping Science conducted yearly harmonic analysis on tidal data recorded during the year from 2000 to 2005 and obtained the harmonic constant in time sequence. The tide characteristics of the Zhongshan Station was analysed with that harmonic constant. The conclusion was that the tide in the Zhongshan water area is mixed irregular diurnal tide. Based on the analysis of time series harmonic constant it was found that there was a phase leap of the lunar tide in 2001. The reason is not clear and further study is needed.

5. Glacier radar detection in the Arctic

The Key Laboratory of the State Bureau of Surveying and Mapping for Polar Surveying and Mapping Science conducted radar survey in April 2009 on Austre Lovenbreen and Pedersenbreen glaciers in the Arctic and GPS satellite synchronous coordinate data acquisition. The cumulative measurement mileage was about 130 kilometers. The ice thickness and internal structure were detected; the surface topography, subglacial terrain and the volume of the ice were calculated.

(II) Life Sciences

1. Polar microbiology research

Project executor: China Polar Research Center

(1) Classification of strains of psychrophile and cold resistant bac-

teria living in the Arctic sea ice and sedimentary environment; 3 species of psychrophile were named Marinobacter psychrophilus (from sea ice core located at 78° 23'14"N, 149°06'55"W), Phaeobacter arcticus (from the sediment located at 75° 00'24"N, 169° 59'37"W) and Colwellia polaris (cold resistant bacteria from sea ice core located at 77° 30'59"N,152° 52'04")

(2) 338 strains of bacteria from Canadian sea basin were studied for their production of low-temperature enzyme, and their roles in sea ice mass circulation .were preliminarily suggested.

71.6%, 65.7%, 38.5%, 31.6% and 16.9% of the bacteria from sea ice could degrade esters, protein, starch, lactose and chitin. Lipase-producing and protease-producing strains play a key role in the mineralization of sea ice organic matters.

(3) Cold metalloproteinases (MCP-02, E495 M4 family) from Arctic sea ice and deep sea strains was compared with temperature Pseudolys in metalloproteinases from land source. It is proposed for the first time that the dynamic optimization of hydrogen is an optimal way for enzymes to adapt to coldness.

(4) Fifty-three strains of actinomycetes from the rhizosphere soil samples around the Yellow River Station were identified to be from8 genera. Apart from the dominant bacterium Streptomyces bacteria, another six rare genera -Rhodococcus, Saccharothrix, Rathayibacter, Micrococcus, Nocardia and Kribbella- were also found .

2. Polar ecology study

Project executor: Polar Research Institute of China

(1) The abundance, productivity and correlation to environmental factors of micro-phytoplankton and pico-phytoplankton in Kongsfjorden were analyzed. The abundance of autotrophic and heterotrophic pico-plankton are 0.1 x 10^6 cells to 35.2 x 10^6cells L^{-1} and 0.4 x 10^6 to 20.3 x 10^6 cells L^{-1}, respectively. The abundance of autotrophic and heterotrophic micro- plankton are 0.4×10^5 cells L^{-1} to 46×10^5 cells L^{-1} and 0.3×$10^6$to 9.1×10^6 cells L^{-1} respectively. Distinct differences can be found from inside the Bay and outside the Bay. It is found that bacteria and heterotrophic nanoflagellate plays an important role in microbial food cycle in Kongsfjorden, which reflects the influence from Atlantic warm water.

(2) Analysis of glacier melt water and sediment samples of euphotic layer, deep layer and bottom layer water collected in the summer of 2006 shows that summer glacier melt water and seawater collected from the euphotic layer of the bay has great eukaryotic plankton diversity. Glacial

meltwater contains Stramenopila, marine Cercozoa, Alveolata, metazoan, green algae and flagellum. The first five groups are also found in the sea water of the euphotic layer, which also contains micro eukaryotics related to flagellum, brown algae, and Stramenopila. Samples collected at 20 meters and 30 meters only contain algae, while sea water at 200 meters shows greater diversity of organisms. The eukaryotes diversity in bottom sediment is much simpler. The preliminary research confirmed that dinoflagellate, pico-green algae and diatoms are dominant eukaryotic species.

(3) Through photosynthesis experiment and light spectrum measurement over 20s strain of algae, an analysis method based on pigment extraction and fine wavelength analysis on the changes of spectrum absorption point is established.

3. Paleo-ecological study on the sedimentary guano of penguins

Project executor-University of Science and Technology of China

Study on the magnetic susceptibility of sedimentary guano and fresh dung of Ardley penguins in the Vestfold Hills was carried out. The changes of the magnetic susceptibility is caused by both internal and external biomass sources. Rare earth elements are enriched in the soil of weathering surrounding rocks but were significantly low in biological sources such as penguin dung and bryophytes samples. The distribution of rare earth elements (total quantity, ratio of light to heavy rare earth elements, etc.) and corresponding partition models are substitutive indicators used in inversion for the quantity of Antarctic penguins and environment/climate change.

The study on the Ardley penguins on the Vestfold hills shows that the Ardley penguins landed on this island 1800 years ago. The penguin population generally kept increasing in fluctuation. Two troughs in population occurred 900 and 300 years ago, corresponding to the harsh weather conditions of a cold period and little ice age.

4. Research on the historical changes of food nutrition of penguins and seals by using nitrogen isotope

Project executor: University of Science and Technology of China

Comparative study on the sedimen-

tary residual bones and feather deposited and the bones and feather of modern Ardley penguin on Vestfold Hills shows that the value of $\delta^{15}N$ of modern penguins is much lower, which might be related to the krill overstock in the Southern Ocean caused by human activities. The value of $\delta^{15}N$ in the residual bones and feather from the past reflected changes of the proportion of krills, a main food for the penguins, in penguins' diet. The research result shows that human activities and climate changes cause significant impact on eco-systems in the Southern Ocean.

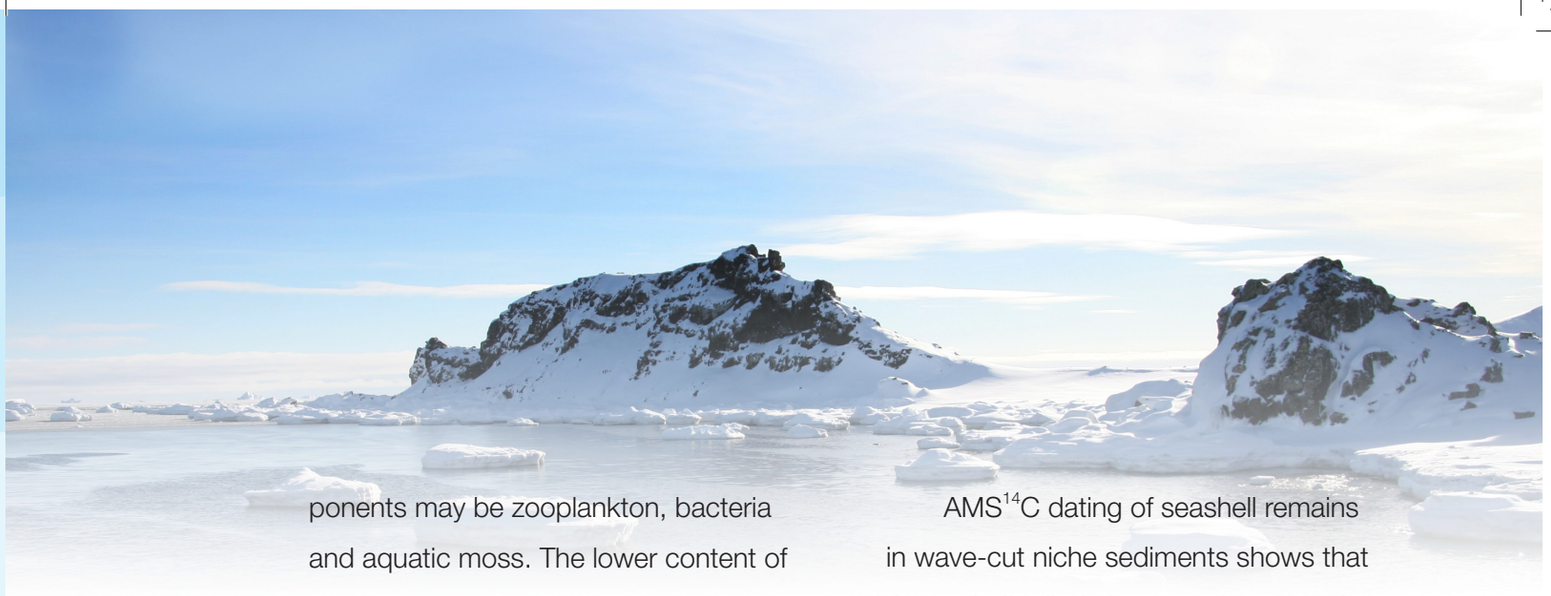
Analysis study on value of $\delta^{15}N$ in hair and guano in the sediment with time sequence on South Shetland Islands shows the rising trend of the trophic level of the seals in the 20th century, which might suggest the reduction of krills, a low trophic level food, in its diet composition, which is in conformity with the decline of the krill population in the last 30 years in the waters of this region.

5. Research on the historical ecological records of molecular organic indicators in animal guano

Project executor: University of Science and Technology of China

Research on the biological molecular organic indicators in sedimentary layer of the penguin's guano on the Vestfold Hills close to the Davis Station shows that the sedimentary layer of penguin guano came from the input of bacteria and algae of freshwater lakes; a large quantity of thermophilic and acidophilic bacteria existed in the freshwater lakes, which provided an oxidizing environment. Alcohols can be used as an indicator showing changes of penguin population; Phytol can be adopted as the indicator for changes of plants there. Saturated fatty acids in the component acids mainly came from zooplankton, bacteria and aquatic macrophytes; C_{24} saturated fatty acid indicates the existence of the only aquatic moss-triserial bryatae. The Study on the population changes of the penguins and the abundance of the plants in the last 8500 years on the Vestfold Hills shows that the population changes of the penguins is closely linked to the abundance of algea and aquatic moss in lakes, and also closely linked to the climate and environment changes.

Research on the short time scale of biomarkers of ecological history shows that the main source of seal guano is mainly from the input of freshwater algae, bacteria and moss. Alcohols components represent the vegetation and the seal guano deposited input, indicating the regional ecological change in historical period. Main sources of fatty acid com-



ponents may be zooplankton, bacteria and aquatic moss. The lower content of unsaturated fatty acid represents a single and stable sedimentary source with less fluctuation. The seal population increased in the 1960s and fluctuated afterwards. The abundances of vegetation changed greatly in early time and the content decreased in late period.

6. The Arctic ice-free area paleo-eco-geology study

Project executor: University of Science and Technology of China

Research on the seabirds' guano deposited in marine-troughs shows that sea birds landed onto the Ny-Ålesund area of the Arctic 9400 years ago. The seabids' population grew rapidly at the beginning and reached maximum level 6900 years ago. Then seabird population underwent significant population changes for 3 times. Such significant changes were synchronized with sea ice rafting events in the north Atlantic. It might be related to the fluctuation of the primary productivity in Svalbard area caused by the powerful current in the Gulf Stream and food source declining.

AMS^{14}C dating of seashell remains in wave-cut niche sediments shows that these shells died almost at the same time 9400 years ago, which represents a sudden climate event. Temperature restoration with carbonate of the shells indicates that the sea water temperature was one degree higher than at the present. It was a natural disaster and nothing related to human activities.

High resolution comparisons show that the cold event was not isolated, but was also reflected in the changes of solar radiation as well as in the surface tempra-ture changes in the North Atlantic Ocean.

7. Eco-environmental Study on the sediments in lakes of the Arctic

Project executor: University of Science and Technology of China

The ecological environment records in sediment pigments were retrieved. In relatively cold little ice age periods, climate caused an negative impact on the growth algae in lakesl Productivity of lakes declined, low sediment pigment occurred, and biological silicon content decreased;

After the little ice age period, temperature rose and algae in lakes grew rapidly and productivity of the lakes greatly improved, but the biological silicon remained at a low level, which might be related to the fast growth of other algae. The last 100 years have witnessed continuous growth of blue green algae, suggesting the increase of human avtivities in the Arctic may have caused nutrient level in lakes to increase.

Lake sediment trace element geochemistry and climate environmental record restoration. Through physical and chemical analysis of lake sediment, the results show that during the last 2000 years, the sectional lithology was uniform and element content does not change significantly in the sediment of the lakes.

Sediment mercury environmental geochemistry. Mercury sedimentary flux from the year of 1770 to 1900 basically changes with global mercury production, which indicates that the meucury pollution in the Ny-Ålesund area was mainly because of long distance air transport. From the beginning of the 20th century, mercury sedimentary flux kept rising. It might be the result of mercury pollution caused by local mining activities. The sedimentary flux of mercury decreased from the late 1970s, which reflected reduced industrial use of mercury and closure of the local coal mine in 1963.

8. Marine boundary layer atmospheric chemistry study

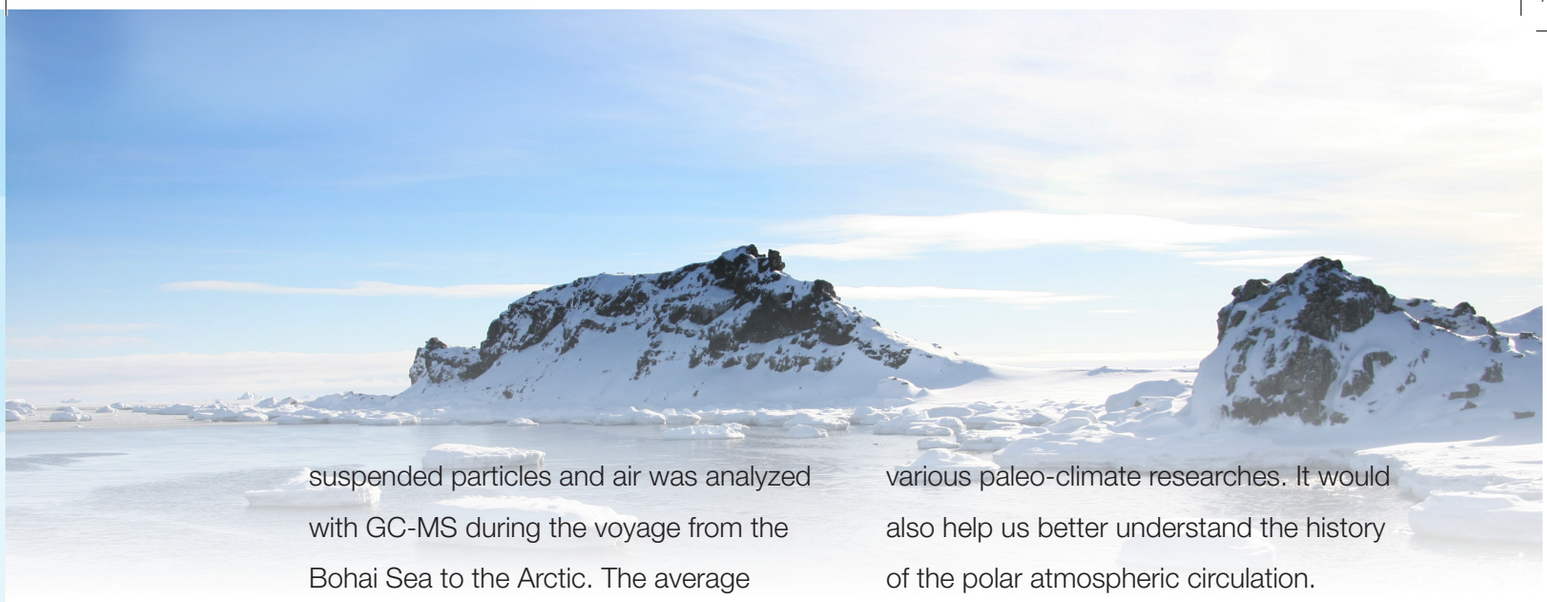
Project executor: University of Science and Technology of China

(1) Environmental Geochemical study-concentration of mercury of marine boundary layer

The background concentration of total atmospheric mercury in the marine boundary layer was obtained on the voyage from Shanghai to the Zhongshan Station and from Shanghai to the Arctic Ocean. Total hg concentrations are 0.302 - 4.496 ng/m^3, with an average of 1.536 ng/m3. Northern and southern hemisphere average concentrations are respectively 1.746 and 1.471 ng/m^3. In coastal areas outside the polar region, mercury concentrations are higher due to the long distance transport of pollutants discharged from adjacent land. In coastal areas close to the island of Bali, because there was volcanic ash, the mercury concentrations in the atmosphere increased sharply. Total mercury concentration in the coast area of the Atarctic appeared higher in daytime and relatively lower at night. This variation of mercury concentration in the coastal areas of the Antarctic reflects that mercury in water might be reduced and then released to the atmosphere.

(2) Air persistent organic pollutants in the Arctic

The total DDT concentration in both



suspended particles and air was analyzed with GC-MS during the voyage from the Bohai Sea to the Arctic. The average value of the total DDT is 13.1 pg/m^3; the lowest concentration is 0.52 pg/m^3; and the highest concentration is 265 pg/m^3. Relatively higher concentrations of DDT appeared in the coastal areas close to the Bohai Sea and the east coast of Russia. In the Far East and the High Arctic region, DDT isomers composition types are obviously different. 94% of DDT originated from human activities. DDT in the Far East was found relatively fresher than those in the Arctic and northern Pacific regions, being less subject to photodissociation.

Marine boundary layer biological aerosol research.

A total of 29 genera were identified from pollens collected in tropical and temperate zones and the Antarctic region. Among identified genera/species, pollens of the Pinus genus and the Cruciferae family were most often found and other pollens only sporadically occurred. Study on modern pollens in high latitudes can be used to establish polar pollen-climate transfer functions or climate-pollen response models, which can be applied to various paleo-climate researches. It would also help us better understand the history of the polar atmospheric circulation.

9. Laboratory simulating study on the source and emission of greenhouse gas from the Antarctic tundra region

Project executor: University of Science and Technology of China

(1) Impact on origination and emission of greenhouse gases during freeze-thaw cycles in Antarctic tundra regions

This study found that when penguins' dung and guano are in an frozen state, their greenhouse gas emission flux is very low, while in thawing their N_2O, CH_4 and CO_2 emission flux drastically rises. Organic C and N released by marine animals during the freeze-thaw cycle play an important role in the origination and emission of greenhouse gases. Such greenhouse gases released during the freeze-thaw process contributes a large portion of the total green house gases released by the Antarctic tundra system. Details of the research can be found in Atmospheric Environment (2009, 43: 2336-2347).

(2) Reseach on the potential of the origination and emission of Antarctic greenhouse gases in Antarctic tundras.

In aerobic or anaerobic conditions, the rate of CO_2 and CH_4 production from penguin feces is significantly higher than from penguin quano, and their emission rate is positively correlated to TOC. Under anaerobic conditions, penguin feces/guano show higher N_2O production rate,which shows that denitrification contributes the largest part of N_2O production. Further analysis shows that marine animal fecal materials are an impoartant factor governing the C and N nutrient pools and their compositions in Antarctic tundras and significantly affect the present and future greenhouse gas emission of the region. For details of the research, see Antarctic Science (2009, doi:10.1017/S0954102009990204). In addition, through laboratory simulation, effects of such factors as thawing manner, thawing temperature, moisture, pH value, etc. on the production and emission of phosphine by various environmental media in Antarctic tundras were examined. For details of the research, see Journal of Environmental Sciences (2009, 21: 150—154).

10. Research on the vertical distribution of zooplankton

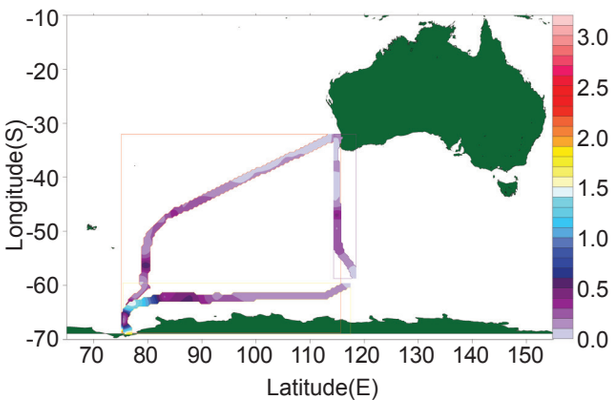
Project executor: Institute of Oceanology, Chinese Academy of Sciences

Analysis of the vertical distribution of zooplankton community in the nearshore ice edge areas of Prydz Bay shows that the total abundance of zooplankton was 3596 ind m^{-2} between 0-500 m, in which the abundance between 0-25 m accounts for 48.5% of the total abundance. The abundances between 25-50m, 50-100m, 100-200m and 200-500m contribute 6.2%, 7.9%, 16.2% and 21.3% of the total respectively.

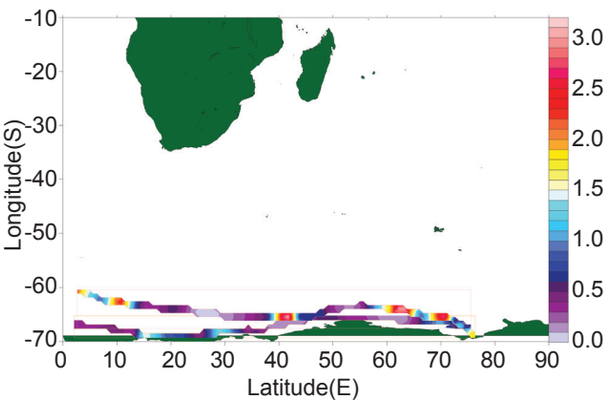
11. Study on surface chlorophyll-a in the Souther Ocean and surrounding waters of Antarctica

Project executor: Institute of Oceanology, Chinese Academy of Sciences

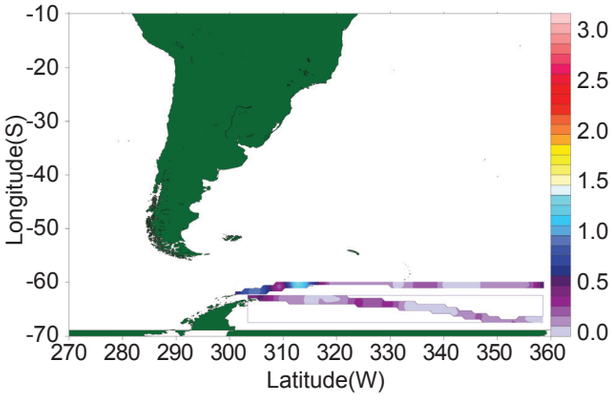
During the 24th Chinese Antarctic expedition, 590 surface chlorophyll-a samples were collected and 520 samples were collected during the 25th expedition by R/V Xulong on its way to Antarctica. During the voyage from Fremantle, Australia to Prydz Bay, Antarctica, the concentration of chlorophyll-a is low in the samples collected and the concentration of chlorophyll-a rose higher in the samples collected in the Prydz Bay.(as shown in fig. A1). Marine surface concentration of chlorophyll-a is found to be higher in the East Hemisphere than in the West Hemisphere based on analysis



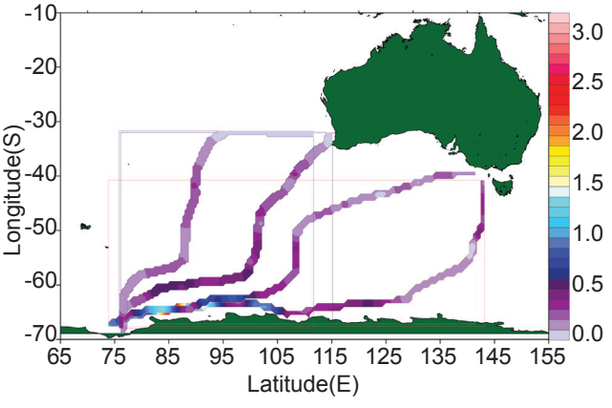
■ *Fig.A1 Surface chlorophyll-a in the Southern Ocean and Prydz Bay (2007-2008)*



■ *Fig.A2 Surface chlorophyll-a in surrounding waters of the Antarctic continent (2007-2008)*



■ *Fig.A3 Surface chlorophyll-a in surrounding waters of the Antarctic continent (2007-2008)*



■ *Fig.B Surface chlorophyll-a in the Southern Ocean and adjacent waters of the Antarctic continent(2008-2009)*

of the samples collected during the Prydz Bay-Great Wall Station-Prydz Bay circum-Antarctic voyageStation. The surface concentration of chlorophyll-a is higher in the water area of Antarctic peninsula where the Great Wall Station is located, while the surface concentration of chlorophyll-a is low in the Weddell sea water area (as shown in fig. A2, A3). The data of surface concentration of chlorophyll-a of the sample collected during four profile surveys on the 25th Chinese Antarctic Expeditions shows that the surface concentration of chlorophyll-a in the samples collected in waters north of 63°S has no significant changes compared with that of 2007-2008, and the surface concentration of chlorophyll-a is higher in coast areas of the Antarctic continent. Compared with data of 2007-2008, the averaged value of the surface concentration of chlorophyll-a is lower, but the maximum value is higher. (as shown in fig.B)

12. Discovery of new anti-tumor active substances in Polar microorganisms

Project executor: National Marine Environment Monitoring Center

Sixty-four strains of bacteria, 16 strains of actinomyces and 6 strains of fungi were isolated from marine sediments in Polar regions. 18 strains of bacteria, 6 strains of actinomyces, 3 strains of fungi were separated from lake sediments, 24 strains of bacteria, 9 strains of actinomyces and 5 strains of fungi were isolated from soil samples. The isolated microorganisms were screened and 12.4% of them have anti-bacterial activity, 6.2% of them has anti-tumor activity and 3 strains have both anti-bacterial and anti-tumor activity.

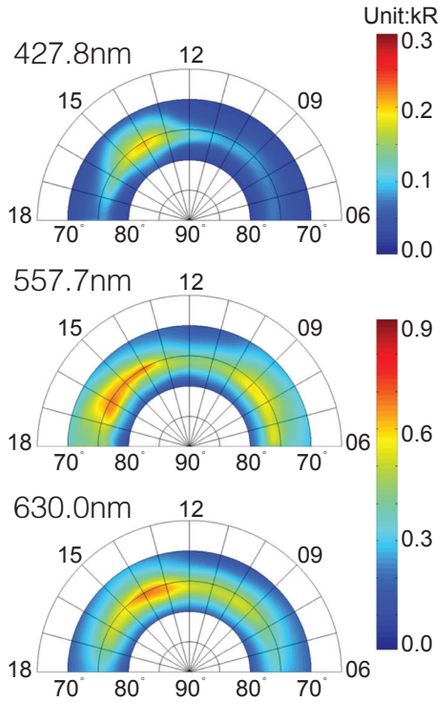
(III) Physical sciences

1. The aurora characteristics study

Project executor : Polar Research Institute of China

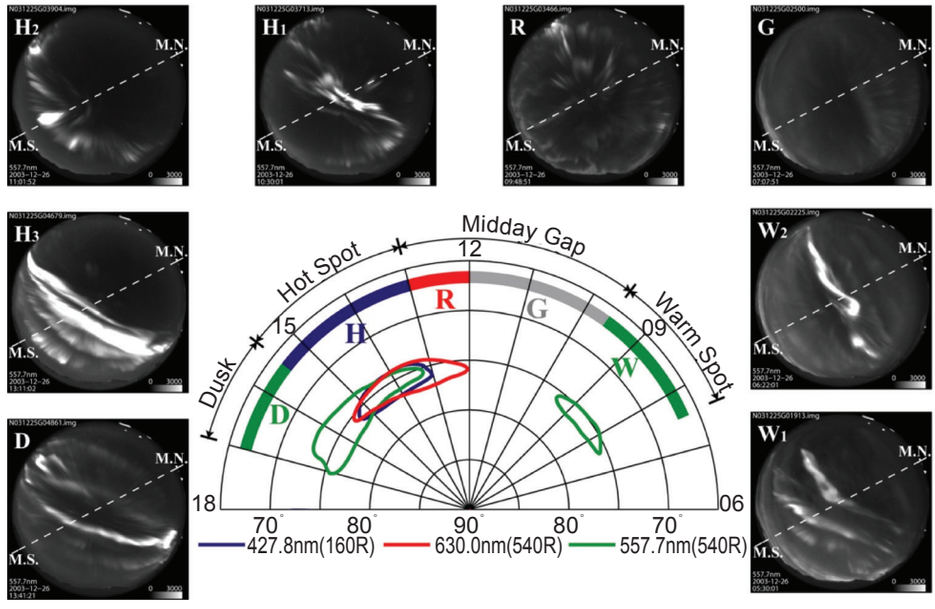
Comprehensive research was carried out on dayside aurora based on all–sky aurora observation data obtained at three bands (427.8,557.7 and 630.0nm) during the past 4 years (2003—2006). It is identified that two peak areas of auroral activity exist in the dayside auroral oval, i.e., an aurora “warm spot” at 09:00MLT and an aurora “hot spot” at 14:00-15:00MLT. In addition, land-based observation shows that the aurora excitation peaks at all three bands are in the afternoon sector, although the excitation peak of each band covers a different MLT sector.

According to the multi-spectral property of aurora, the dayside auroral oval



■ *Fig 1 Distribution of the average density of aurora at 3 bands on MLT-MLAT coordinate system. From top to bottom are density distributions of dayside aurora at 427.8nm, 557.7nm and 630.0nm. The colored bar on the right indicates the average density of aurora.*

can be divided into four auroral activity regions: the green “warm spot” before noon (W) (07:30-09:30 MLT), the green midday gap (M) (09:30-13:00 MLT), the afternoon aurora “hot spot” of dayside auroral excitation peak (H) (13-15:30 MLT) and the green “dusk aurora area” (D) (15:30-17:00 MLT). Also, in every aurora activity area, there is a typical aurora form: the W area is a green discrete ray arc, including a polar-ward ray arc and a bright east-west ray arc; the M area has less strong curtain-type crown-shaped dayside aurora and red radial crown-shaped dayside aurora; the H area has excitations rising rapidly at all three bands simultaneously, including ray-belt that moves polar-ward with intensity increasing quasi-periodically, a discrete bright ray cluster and a bright auroral arc; and the D area is mainly an east-west green auroral arc.

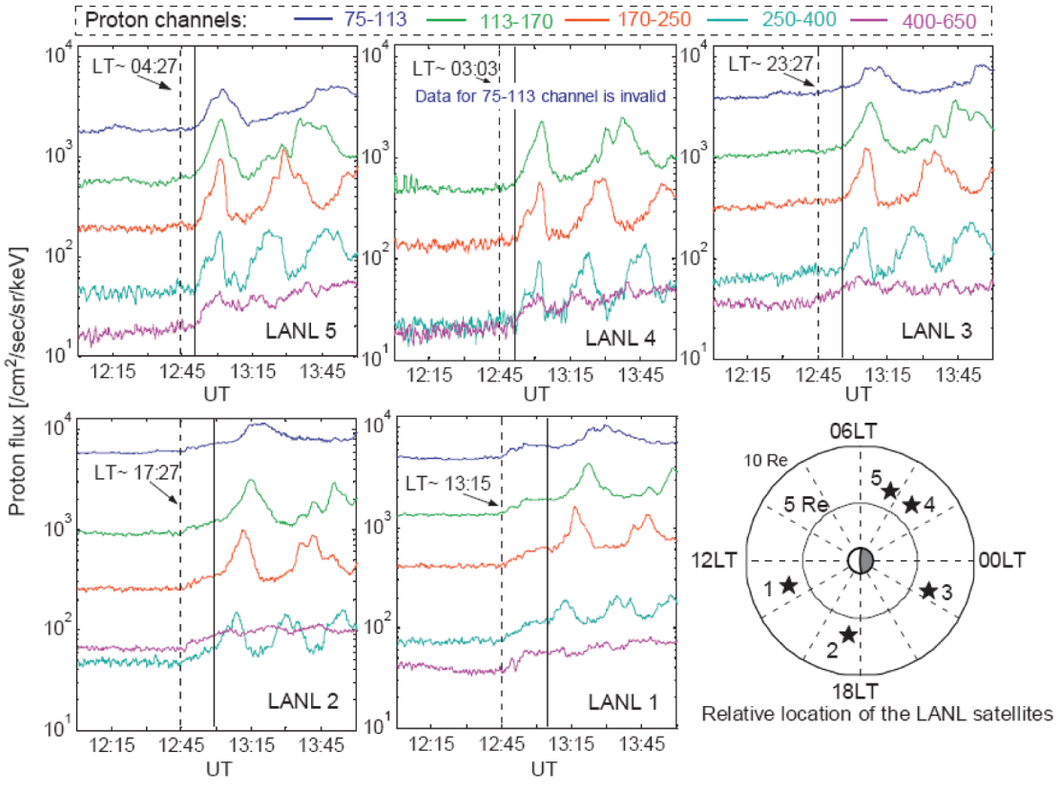


■ *Fig 2 Distribution of day-side aurora activity (middle); surrounding diagrams are 2D diagrams of day-side aurora activity on Dec. 26, 2003.*

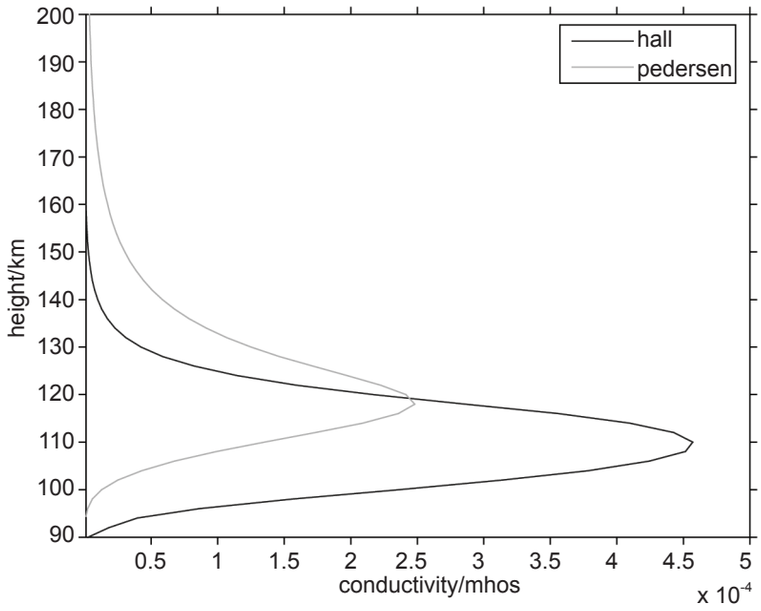
2. Dynamics research on the ionosphere and magnetosphere

Project executor : Polar Research Institute of China

Simultaneous observation from multiple earth-synchronous orbit satellites with different local times confirmed that two effects can be caused by sudden increase of solar wind dynamic pressure on the magnetosphere: (a) sharp increase of dayside particle energy flux corresponding to ground geomagnetic sudden commences caused by sudden increase of solar wind dynamic pressure; (b)earthward proton injection on the dawn side about 7 minutes after ground geomagnetic sudden commences occur. The former has been extensively studied, while the latter is obviously different from earthward particle injections that occur during substorms. This study suggests that this phenomenon is due to the acceleration of thermions within the plasma sheet by the east-west electric field transmitting magnetotail-ward that occurs in the magnetosphere when it is under solar wind dynamic pressure.



■ *Proton energy flux recorded by five LANL satellites between 12:00-14:00. The dotted and solid lines represent the time geomagnetic sudden commences start and the time energy flux begins to increase due to particle injection as observed by the satellites. For the relative locations of the 5 satellites at the time geomagnetic sudden commences begin, see Fig 6.*



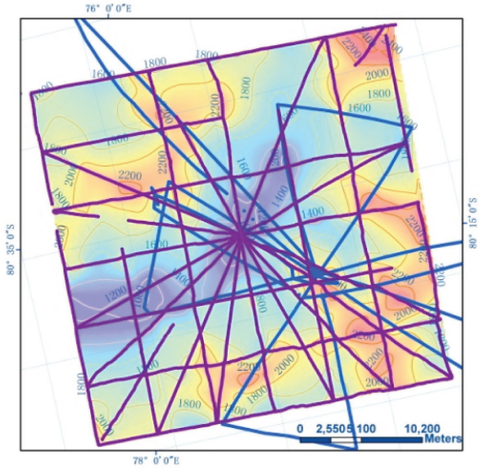
■ *Fig. 4 Model generated altitude profile of midday inospheric conductivity over the Zhongshan SStation*

Effect on the Polar ionosphere of precipitation of electrons of different energy spectrums. Study shows that precipitation of electrons of different energy spectrum distributions does not have much different effects on conductivity of the ionosphere. When energy flux is fixed, average energy is a key factor affecting electrical conductivity; and the energy spectrum has significant effect on concentration of electrons in the F layer. As average energy increases, energy spectrum has more impact on electron concentration. While average energy is above 1KeV, the modified Maxwell distribution spectrum can significantly enhance F layer electron concentration.

3. Study on origin and evolution of Antarctic ice sheet through ice-penetrating radar survey over Dome A

Project executor : Polar Research Institute of China

During Antarctic surveys on Dome A



■ *Radar surveying lines on Dome A during 2004-2005, 2007-2008*

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LETTERS

The Gamburtsev mountains and the origin and early evolution of the Antarctic Ice Sheet

Sun Bo[1], Martin J. Siegert[2], Simon M. Mudd[2], David Sugden[2], Shuji Fujita[3], Cui Xiangbin[1], Jiang Yunyun[1], Tang Xueyuan[1] & Li Yuansheng[1]

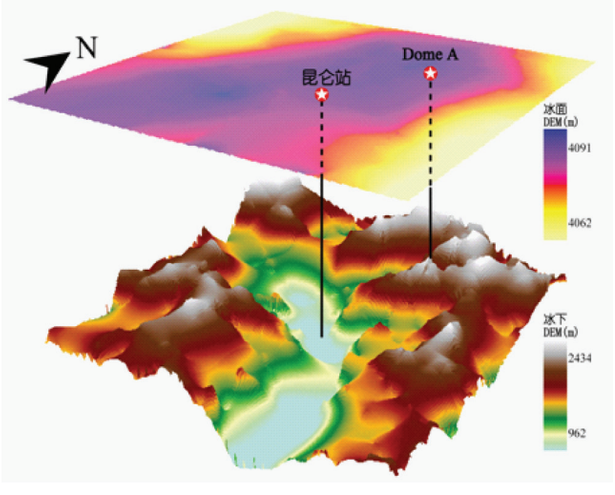
carried out in 2004-2005 and 2007-2008, ground bi-frequency multi-polarized vehicle-mounted ice radar systems were used to collect data for a 900-square-kilometer central area of Dome A. Based on these data, the first topographic map of the Gamburtsev Subglacial Mountain Range was made, which reveals three main stages and time series of the evolution of the glacier/ice sheet in the Gamburtsev area over the last 34 million years.

(1) The Antarctic Gamburtsev Mountain used to have well developed river system. Glaciers appeared 34 million years ago. Along with the periodical changes of Earth orbit, climate went cold, glacial areas gradually expanded, and this region became a key originating source of the Antarcitc Ice Sheet.

(2) Super large-scale U-shaped valleys suggest that during the period from 34-14 million years ago, this mountain region experienced intense glacier erosion. Glacier dynamics modelling shows that such intense glacial geomorphology could only appear when temperature was no less than 3℃ in summer in this central part of Eastern Antarctica.

(3) As the result of ice sheet expansion over the past 14 million years, the mountains were covered by ice and landforms under the ice sheet have been preserved.

(4) The Eastern Antarctica Ice Sheet exhibits surprisingly strong stability against climate changes over the last 14 million years, which may call for more



■ *3D topography and landform beneath the Ice Sheet*

understanding of ice sheet dynamics, the nonlinear response of ice sheet to climate change and impact of ice sheet on sea level changes.

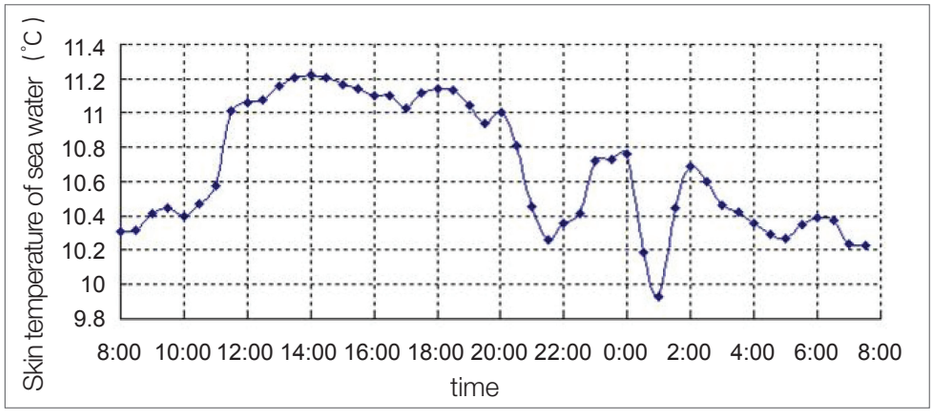
4. Satellite remote sensing and field observation of Arctic Ocean flaw leads

Project executor : Polar Research Institute of China

Underway measurements of sea water and sea ice skin temperature was carried out on the Third Chinese Arctic Expedition from R/V Xuelong. The POW algorithm was improved based on in situ surveys and flaw leads were extracted from infrared remote sensing images; the spatial-temporal and climatological variation of flaw leads was analyzed.

The highest sea water skin tempeature outside Nome Port appeared at 2:00pm local time and the lowest temperature appeared at 1:00 am. The temperature declines after 2:00 pm and after reaching the valley bottom around 9:00pm it rises again for sometime until it begins to fall toward the daily minimum, a pattern slightly different from the daily change of water temperature in other areas.

With polynias, leads and ice ridges scattered here and there across the ice-covered parts of the Arctic Ocean, the thickness of ice is quite uneven. Preliminary comparisons between sea water



■ *Daily changes of sea water skin temperature outside Port Nome on July 29, 2008*

■ *Ice distribution in the Arctic Ocean*

and sea ice skin temperatures show that sea water skin temperature is slightly higher than ice skin temperature and the maximum differences can be 1~2K. The difference is larger when air temperature is lower; when air temperature becomes higher, the difference is smaller.

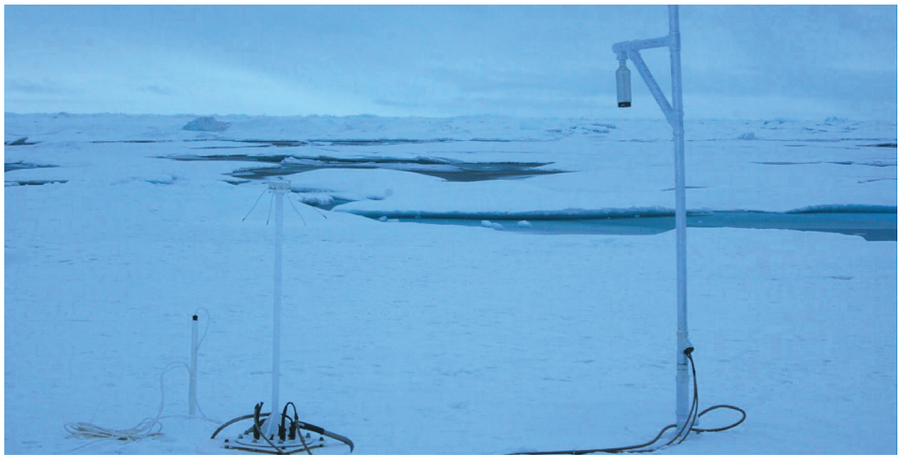
5. Combined observation by satellites and sea ice buoys in the Arctic Ocean

Project exe cutor : Polar Research Institute of China

Satellite tracked drifting buoys were deployed in the multi-year ice area of Chukchi Sea of the Pacific sector of the Arctic Ocean during the third Chinese Arctic expedition for real-time long time sequence measurement of air temperature, ice temperature, air pressure and thickness of ice. Ice cores were obtained through ice drilling and analysis was carried out of internal structure and salinity distribution of the ice cores; temperature and salinity measurement of sea water under the ice was conducted; observation of atmospheric boundary layer was conducted, including in situ measurement of air-ice interface turbulence momentum and heat exchange. These measurements would provide reliable data for researches on variation of the physical properties of sea ice and key physical processes involved in air–ice–sea interactions.

■ *Fixing a temperature chain*

■ *Connecting sensors to the buoy*



■ *Deployed IMB buoy*

6. Combined observation by satellites and sea ice buoys in the Southern Ocean

Project executor: Polar Research Institute of China

Satellite tracked sea ice buoys (IMB) were deployed by the 25th Chinese Antarctic Expedition's wintering team in Prydz Bay. The buoys were deployed in an area where thickness of sea ice is about 1 m with temperature chains a borameter and a sonar system mounted.

■ *Seawater satellite buoy system*

7. Underway measurement of sea water and sea ice skin temperatures in the Southern Ocean

Project executor: Polar Research Institute of China

Assisted by Heilongjiang Surveying

and Mapping Bureau, the project was carried out from October 2008 to May 2009. The raw data acquired include data collecting time and water/ice skin temperature. In the open sea, data were collected at intervals of 2 seconds, and 1 second in ice areas. Data for 25 days were collected on the outward voyage without interruption.

8. Underway integrated flux observation in the Southern Ocean

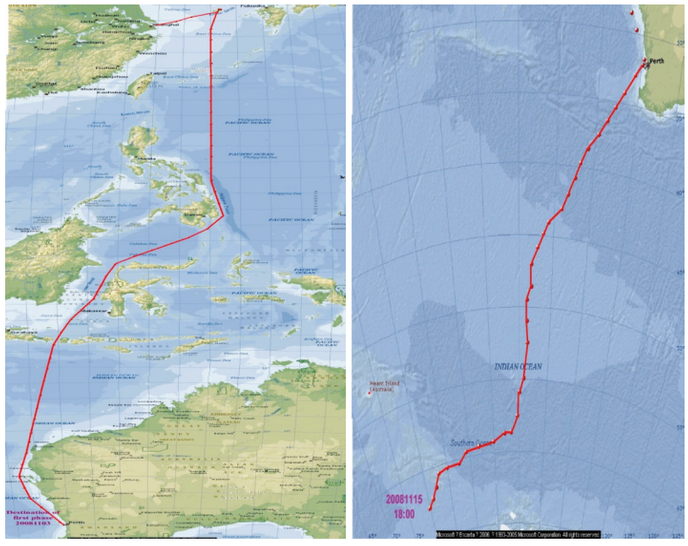
Project executor: Polar Research Institute of China

During the 25th Chinese Antarctic Expedition, integrated flux observation, which included measurements of fluxes of sea-air momentum, heat, water vapor and CO_2, were carried out. Data for water vapor, heat and CO_2 fluxes in longitudinal direction through both north and south hemispheres were gained. The navigation route is about 25000 nautical miles from Shanghai–Pacific Ocean–Indian Ocean-Southern Ocean to the Zhongshan Station. 25GB of observation data were obtained.

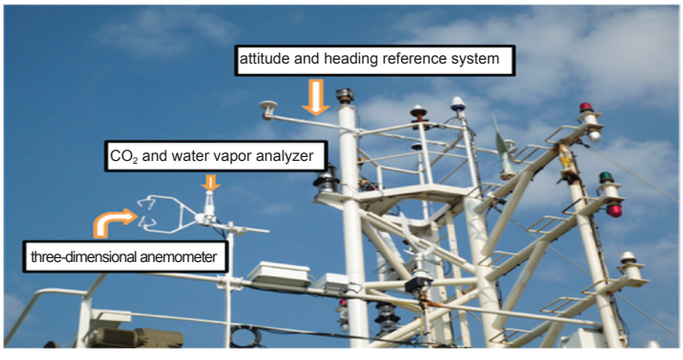
9. Analysis on DT263 ice core

Project executor: Polar Research Institute of China

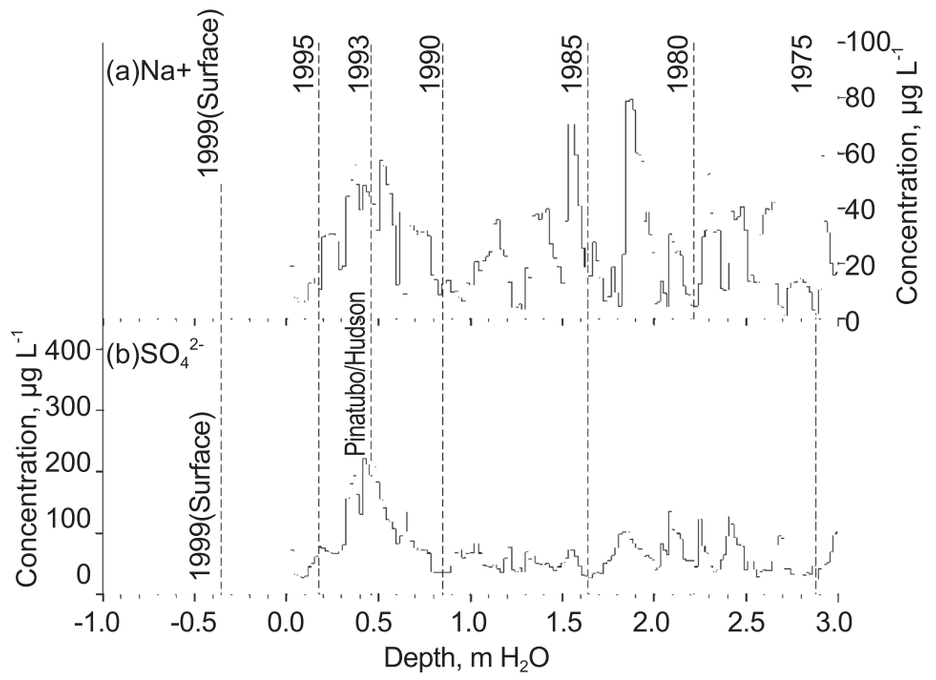
The DT263 ice core taken from Princess Elizabeth Land, Eastern Antarctica (77°01'50"E, 76°32'50"S) was analyzed to restore climate records for the past 780 years. Dating of the ice core (Fig.9.1 and 9.2.) shows that it covers a time sequence of about 780 years between A.D. 1207-1996. Analysis of non-sea-salt sulfate ($nssSO_4^{2-}$) in the ice core and comparison with several other ice cores taken from the Arctic and Antarctica revealed detailed records of 17 volcanic eruptions (table 9.1).



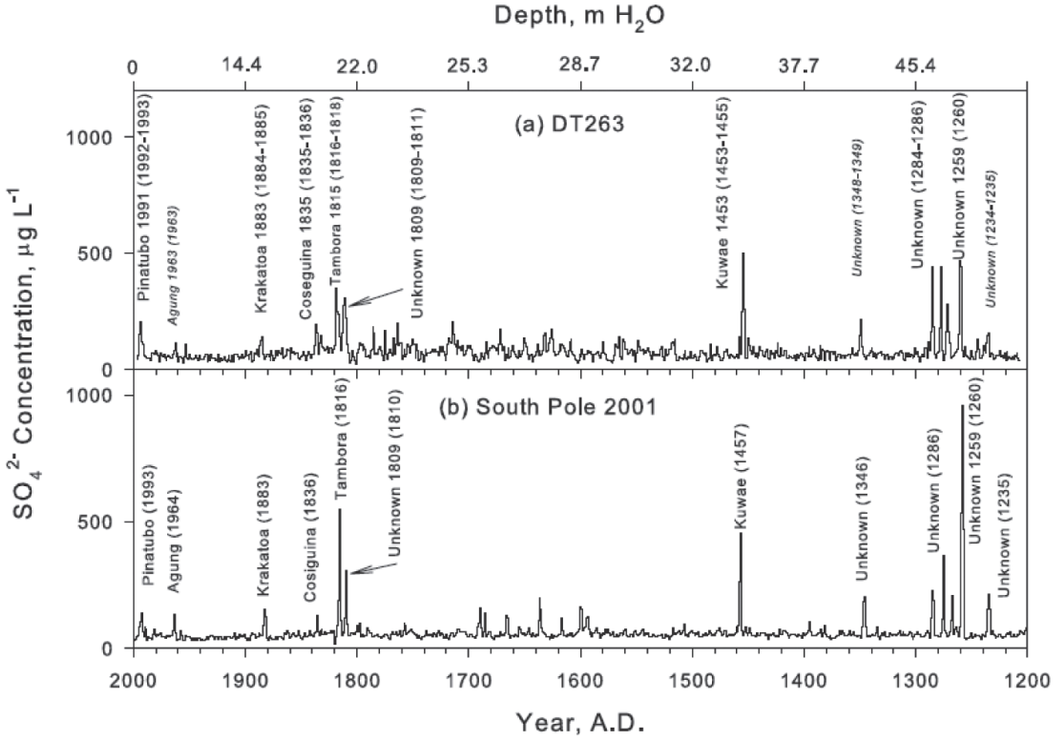
■ *Navigation route of underway measurement of the sea water and sea ice skin temperature in the Southern Ocean*



■ *The underway integrated flux observation system mounted on R/V Xuelong*



■ *Fig 9.1 Time-sequence (0–17.0mH_2O) determined based on seasonal variation of Na^+*



■ *Fig. 9.2 Time-sequence (17.0–53.6 mH_2O) determined based on volcano events for the lower section of ice core DT 263 (compared with volcano events recorded in ice cores retrieved at the South Pole)*

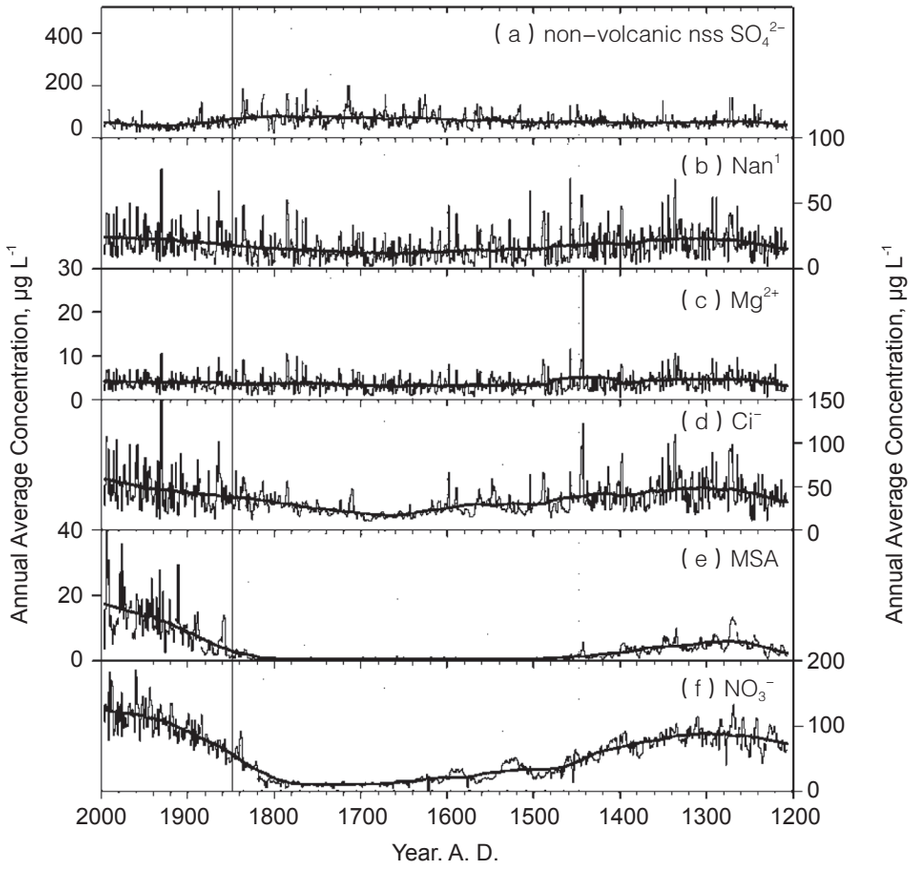
Table 9.1. Volcano flux and sulfate concentration recorded in ice core DT263 and the Plateau Remote ice core

Volcano/time	DT263		Plateau Remote	
	max.value of sulfate / $\mu g \cdot g^{-1}$	volcanic flux/ $kg \cdot km^{-2}$	max.value of sulfate / $\mu g \cdot g^{-1}$	volcanic flux/ $kg \cdot km^{-2}$
Hudson/1991	193.14	12.38	–	3.60
Pinatubo/1991	221.55	28.19	–	
Sub Antarct./1975	127.22	4.63	–	–
Agung and Deception/ 1963	150.09	9.39	194.2	6.68
Santa Maria/1902	119.52	6.51	–	–
Tarawera/1886	150.30	20.67	200.4	9.42
Krakatoa/1883	154.55	37.03	200.4	9.42
Coseg ü ina /1835	249.13	24.05	201.3	6.31
Tambora/1815	364.25	40.54	442	22.39
Unknown/1809	305.59	34.16	285.5	8.3
Kuwae/1453	500.96	50.00	1380.4	133.37
Unknown/1343	242.09	42.45	321.8	14.88
Unknown/1285	488.99	47.73	349	21.05
Unknown/1277	615.00	63.19	672.1	55.39
Unknown/1269	261.67	56.73	259.8	11.85
Unknown/1259	689.76	109.20	566.8	46.3
Unknown/1239	185.90	28.83	453.4	31.21

From the mid 15th century to the 19th century, the yearly accumulation rate dramatically decreased (as shown in Table 2) and the concentrations of Na^+, Mg^{2+}, Cl^-, MSA, and NO_3^- are lower as compared with other time periods (as shown in Fig. 9.3), which suggests significant changes of local climate and environment in consistency with the Little Ice Age of the North Hemisphere.

Table 9.2. The average accumulation rate recorded at different time period in ice core DT263

Time	Average accumulation rate (m H_2O a^{-1})	Deviation	
		from A.D. 1450–1810	from 20th century
1901–1996	0.148	+350%	0%
1884–1900	0.157	+375%	+5%
1810–1883	0.065	+97%	–56%
1451–1809 (Little Ice Age)	0.033	0%	–78%
1207–1450	0.081	+145%	–46%

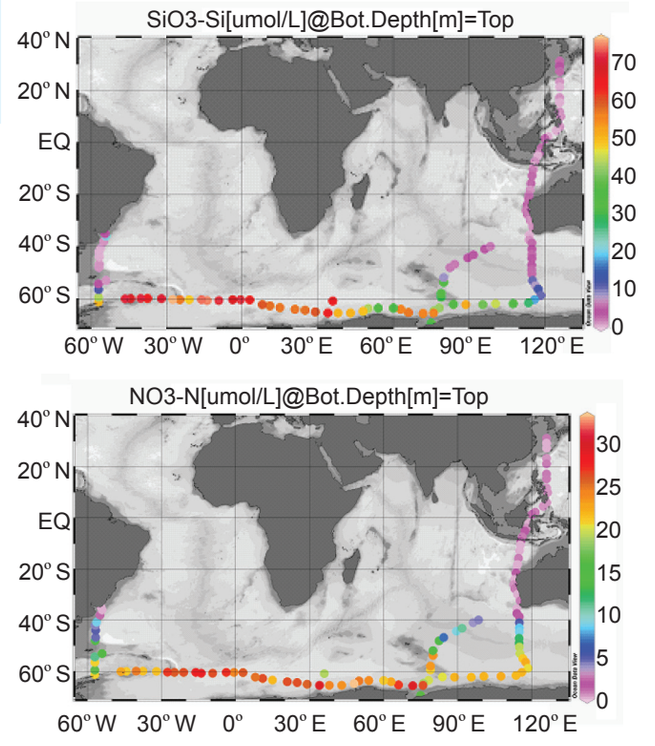


■ *Fig.9.3 Temporal changes of the concentration of positive and negative ions in ice core DT263*

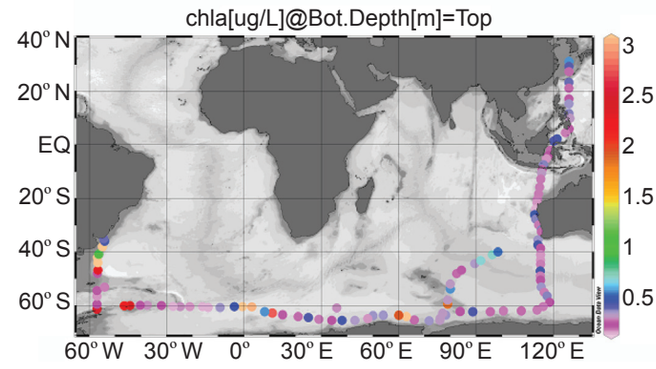
10. Carbon cycle monitoring technology in the Southern Ocean and its application

Project executor: the Second Institute of Oceanography, SOA

(1) According to underway nutrients distribution survey made during the 24th Chinese Antarctic Expedition (figure 10.1), silicate and nitrate content in surface layer sea water shows distinct gradient changes in the polar front area, while the content of chlorophyll-a shows no corresponding change trend (figure 10.2).

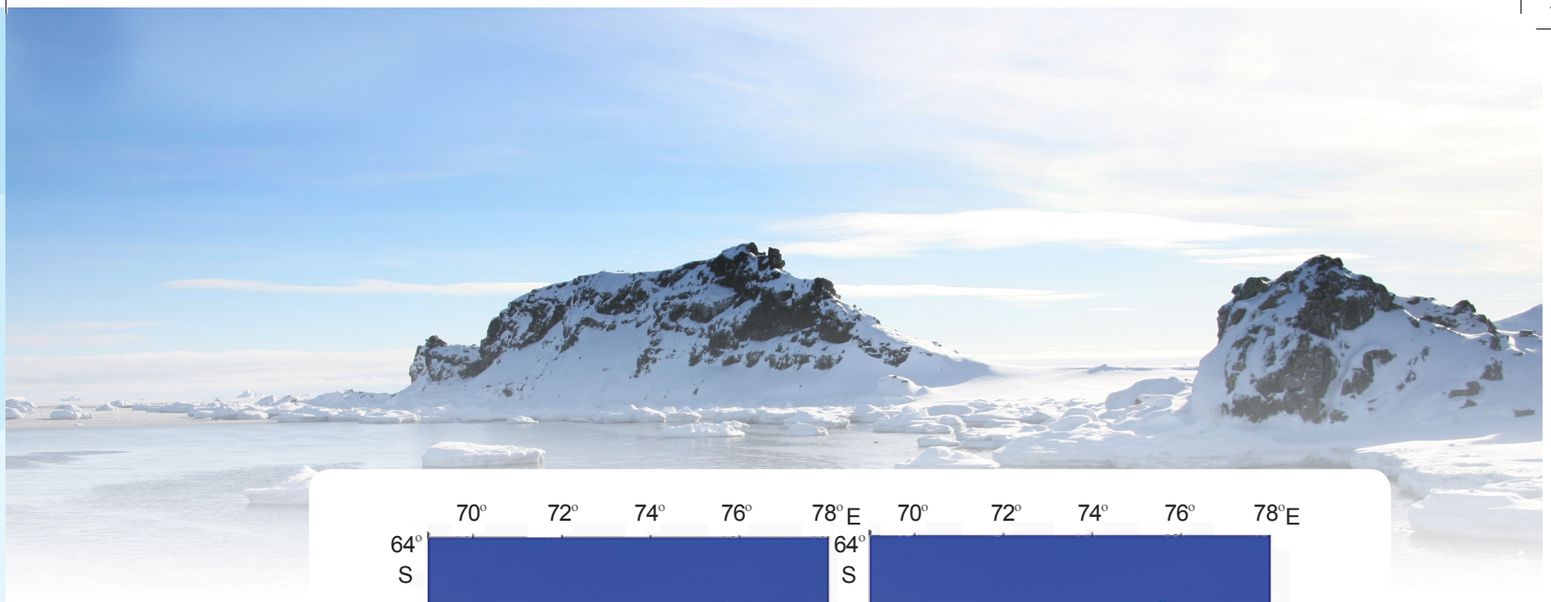


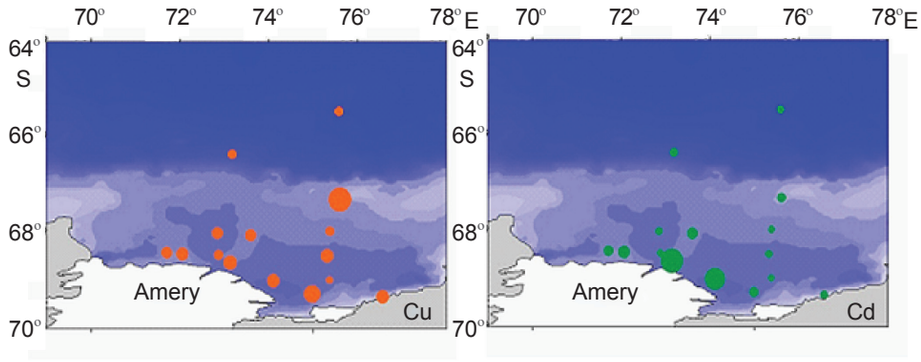
■ *Fig.10.1 Distribution of content; Distribution of content of surface nitrate*



■ *Fig.10.2 Distribution of content of surface chlorophyll-a*

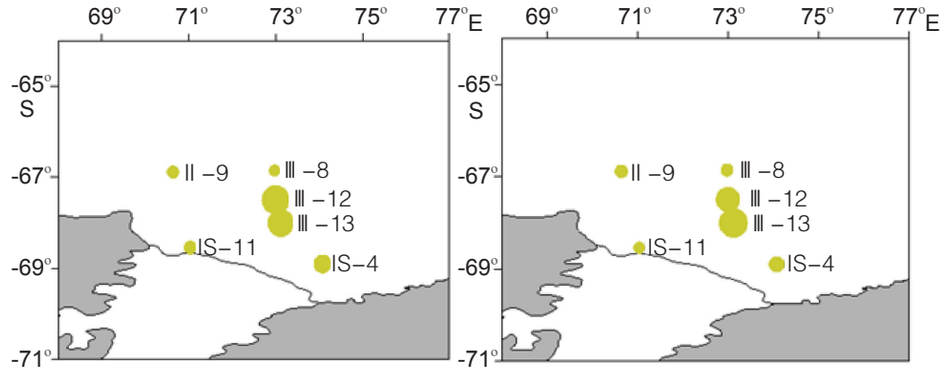
(2) Distribution of the content of copper, cadmium and zinc in the surface layer sea water of Prydz Bay has the following characteristics (figure 10.3): the content of copper and cadmium in the surface layer of Prydz Bay is much close to that in the Southern Indian Ocean, which may suggest that heavy metals in both marine areas may come from similar sources. The heavy metal content in surface sea water of Prydz Bay is similar to that in the lakes of Larsemann Hills. To some extent it supports Gasparo's "sea spray input" theory. Similarity to the content in marine aerosols might indicate that heavy metals might be involved in the process of air-sea exchanges.





■ *Fig. 10.3 Distribution of the content of copper; Distribution of the content of cadmium*

(3) Carbohydrates content and its distribution in the surface sediments of Prydz Bay:The main source of organic matter in the sediments of Prydz Bay is organisms in the upper layer of sea water. The content distributions of carbohydrates and organic carbon in the surface sediments are similar, with marked spatial variation; the maximum value appeared in the area of 73ºE, 67.5ºS. The organic carbon and chlorophyll-a are closely correlated in surface sediments, which reflects the changes of biological productivity in the upper layer of sea water. Biogenic substances are the main source of sedimental organic matter (fig. 10.4).

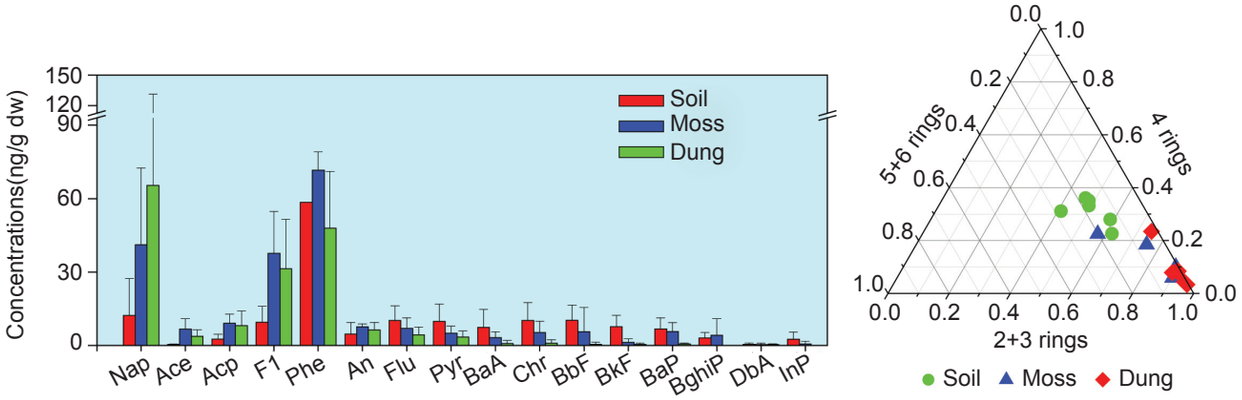


■ *Fig. 10.4 distribution of carbohydrates content; distribution of organic carbon*

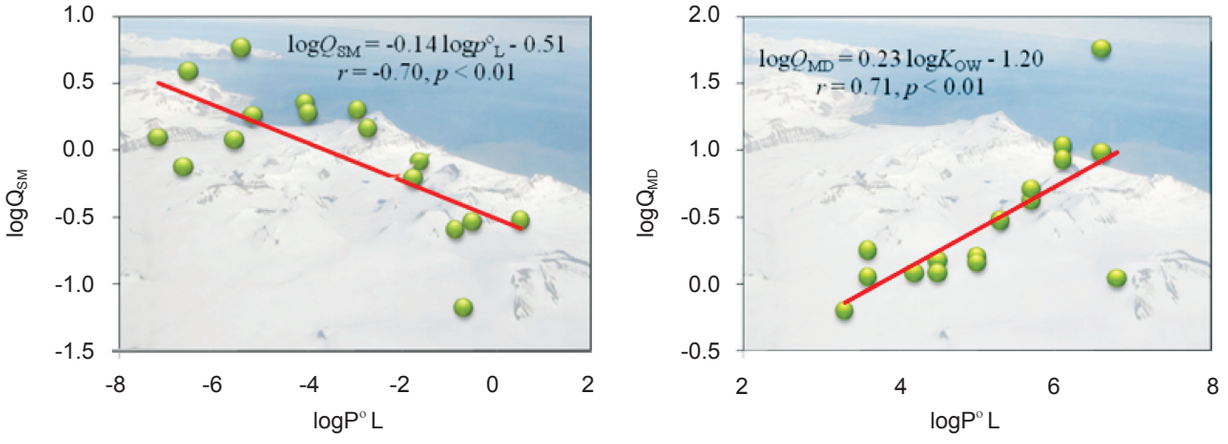
11. Research on the level and trend of persistent organic pollutants

Project executor: National Marine Environment Monitoring Center, SOA

(1) PAHs basic data were obtained through GC-MS analysis for different environmental media in the Arctic (Fig. 11.1). Results show that PAHs with low and medium molecular weights occupy larger proportion, and the proportion for high molecular weight PAHs is lower, which indicates that PAHs come from distant migration process. The content of PAHs of small ring number is lower in soil than that in moss and deer dung, while content of PAHs of large ring number is relatively higher. Study on the relationships between the physico-chemical properties of PAHs can reveal the pattern of distribution of PAHs in environment media (figure 11.2), offering a new approach to research on PTS environmental behavior and fate in remote areas.



■ *Fig.11.1 PAHs concentrations in different environmental media of the Arctic*



■ *Fig.11.2 Patterns of PAHs distribution in different environmental media*

(2) Analysis was carried out on organochlorine pesticides (OCPs) and polychorinated biphenyls (PCBs) in soil, animal dung and moss collected in the Ny-Ålesund area. Comparative study on the ratios between components of HCHs and DDTs and principal component analysis on PCBs homologues were conducted, which confirmed that atmospheric transport is one of the main sources of POPs pollution in the Ny-Ålesund area, which is also true in the case of PCPs.

12. Observational study on the Antarctic atmospheric boundary layer

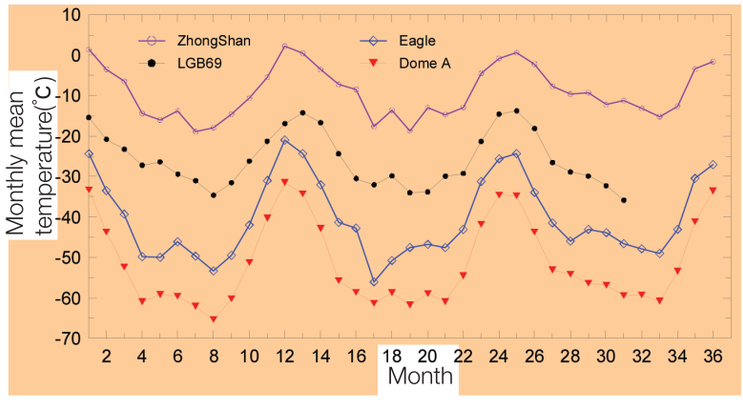
Project executor: China Academy of Meteorological Sciences

Intensive sea-ice-gas interaction and atmospheric boundary layer observations were carried out; turbulent fluctuation and related data were obtained; new boundary layer dynamics and thermal parameters were suggested. These efforts will be significant for further improving the parameterization scheme for the Antarctic boundary layer and forecast accuracy of climate models.

13. Study on climate characteristics of the Antarctic Ice Sheet

Project executor: China Academy of Meteorological Sciences

Analysis of the effect of snow accumulation rate on the height of automatic weather station sensors and observation data was conducted and a correction



■ *Fig. 13.1 Monthly average temperature on the Zhongshan-Dome A profile (2005-2007) after impact of accumulated snow on observing heights was corrected*

method was suggested. The air temperature data continuously collected by three AWSs along the Zhongshan Station-Dome A profile were revised in relation to an actual height above snow surface. Results show that the accumulation rate has strong influence on air temperature nearer to the surface, and the influence becomes smaller as height increases. Air temperature, snow temperature, snow accumulation rate and specific humidity all decrease with the increase of elevation and distance from the coast (figure 13.1).

14. Study on correlations between Antarctic sea ice oscillation index and the climate of China

Project executor: China Academy of Meteorological Sciences

Variations of the Antarctic Circumpolar Wave (ACW) index (1951-2006) and 850hPa Antarctic oscillation west wind index were examined. Results show that in 1973 a pattern change occurred of the ACW in the western Southern Ocean. ACW changes obviously can be divided into three periods: 1951-1973, 1974-1980 and 1981-2006. During these three periods, wind velocity, amplitude and wave structure demonstrated obvious distinctions. In all three periods, ENSO to various degrees impacted climate changes in high latitudes of the southern Hemisphere. The changes of ACW are the superposed effect of ENSO and the Antarctic oscillation at different locations and time.

15. Study on Antarctic regional climate modeling

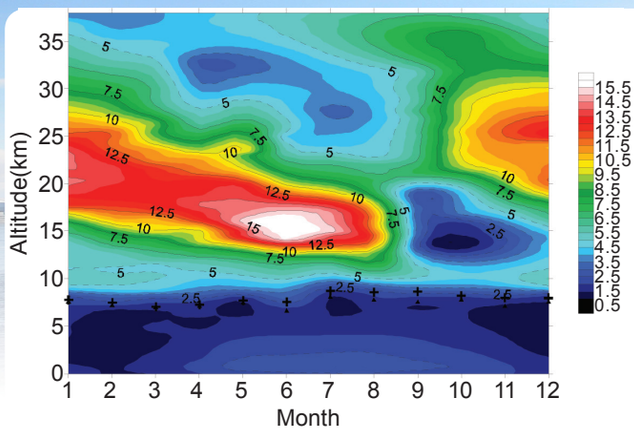
Project executor: China Academy of Meteorological Sciences

In cooperation with the German Alfred Wegener Institute for Polar and Marine Research and using its regional climate model, HIRHAM, a simulation covering 50 years (1959-2008) was run in which ECMWF reanalysis data were used to drive the lateral and bottom boundaries of the model. The atmospheric field generated by the simulation was compared with ground and upper-air observation data.

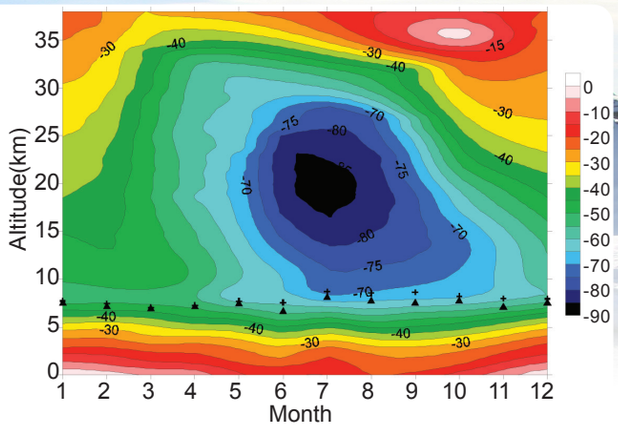
16. Monitoring of atmospheric composition at the Zhongshan Station

Project executor: China Academy of Meteorological Sciences

The Zhongshan Station is the first Chinese station on continental Antarctica. Analysis of the atmospheric background at the station was carried out. With the ozone sounding data collected at the Zhongshan Station during the 24th Chi-



■ *Fig 16.1 Vertical ozone observation profile over the Zhongshan Station. "+" marks the top of heat troposphere, "△" represents the top of ozone troposphere*



■ *Fig 16.2. Vertical profile of temperature over the Zhongshan Station in 2008+ marks the top of heat troposphere, "△" represents the top of ozone troposphere*

nese Antarctic Scientific Expedition, the vertical structure and changes over the year of the atmosphere and ozone were analyzed (figure 16.1-2). Such research is significant for improvement of China's mid/long-term predictability of climate change..

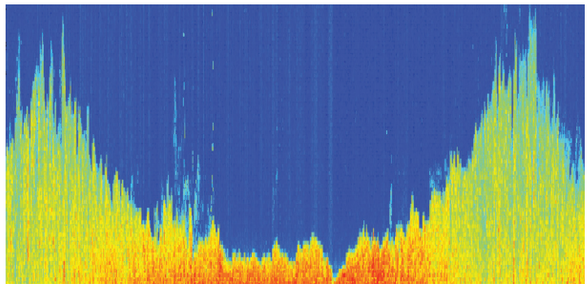
17. The Antarctic astronomical observations

Project executor: Chinese Center for Antarctic Astronomy

More than 100 days of continuous observation were carried out on Dome A since 2008. 400G of observing data were obtained. Through preliminary analysis, dozens of variable stars were observed, including an eclipsing binary star. More than 90% of the night time in winter season on Dome A is photometric. Continuous observation was done in 2009 over the whole Antarctic night and more than 2T of data were obtained.

According to the detection of two acoustic radars in 2008 -2009, the height of atmospheric boundary layer over Dome A was only 9 meters. The Fig. below shows the observation result over two days during day-time by an acoustic radar, which indicates that at night there was almost no turbulence in the atmosphere above 9 meters.

More than 200 days' observation shows that Dome A is an ideal place for millimeter/submillimeter wave astronomical observation.

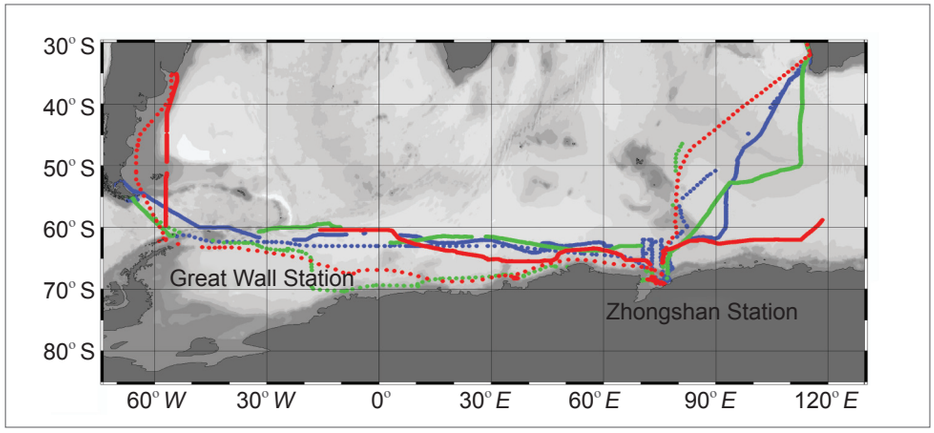


18. The Southern Ocean and western Arctic Ocean carbon pool variability

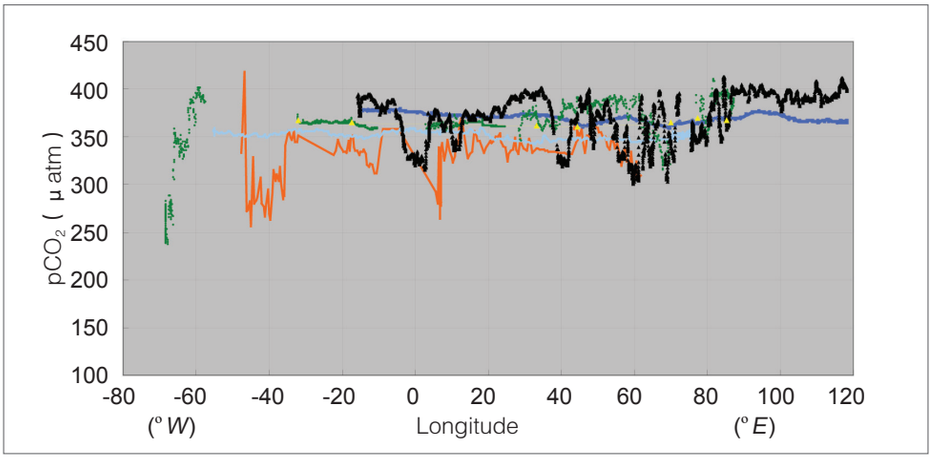
Project executor: Key Laboratory of Global Change and Marine-Atmospheric Chemistry,SOA

(1) Interannual variability of polar atmosphere and sea CO_2 in the context of global climate change

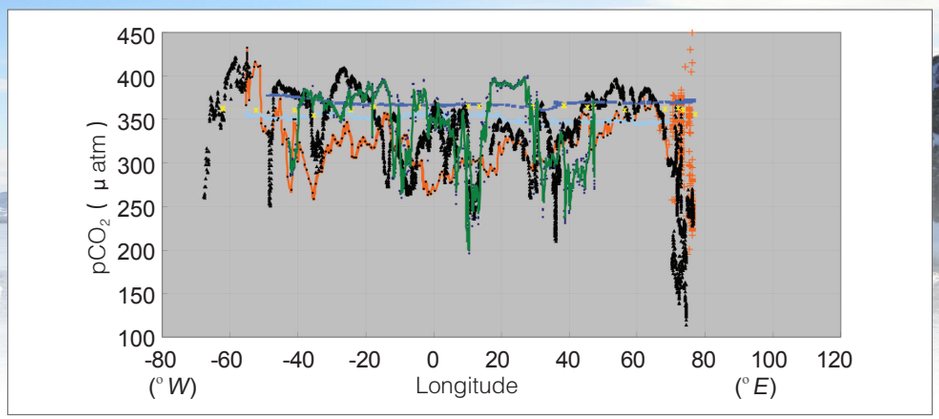
The CO_2 partial pressure (pCO_2) of atmosphere overlying the Southern Ocean increased from 353.8μatm of 1999-2000 to 369.3μatm of 2007-2008, and the surface water CO_2 partial pressure (pCO_2) of the Southern Ocean also increased correspondingly, with an annual average increase of 23.3μatm over 8 years, higher than the increase rate of atmospheric CO_2 partial pressure in each year. Without consideration of wind field changes, carbon



■ *Fig.18.1 Navigation routes of the 16th, 21st and 24th Chinese Antarctic Expeditions. The solid line represents the navigation route of December (from the Gteat Wall to the Zhongshan Station) ; the dotted line represents the navigation rout from January to Feburary (from the Gteat Wall to the Zhongshan Station) . The Blue line is for the 16th expedition ; Green line for the 21st expedition and red line for the 24th expedition*



■ *Fig. 18.2 The variations of pCO_2 distribution of sea surface of the Southern Ocean between the Zhongshan Station and the Great Wall Station in Dec. of 1999, 2004 and 2007 .Atmospheric pCO_2 values: light blue for 1999, yellow for 2004, sky blue for 2007; Sea water pCO_2 values: red for 1999, green for 2004 and black for 2007*



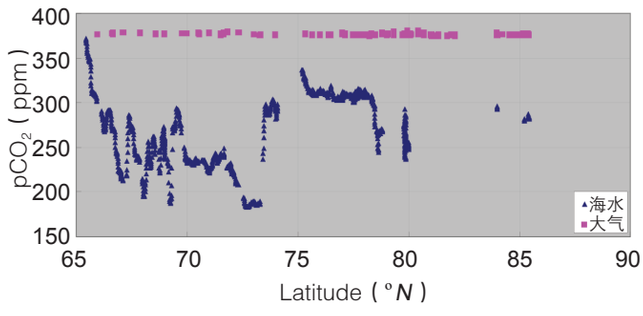
■ *Fig. 18.3 The variations of pCO_2 distribution of sea surface of the Southern Ocean between the Zhongshan Station and the Great Wall Station from Jan. to Feb. of 2005 and 2008. Atmospheric pCO_2 values: light blue for 2000; yellow for 2005; sky blue for 2008; Sea water pCO_2 values: red for 2000; green for 2005 and black for 2008*

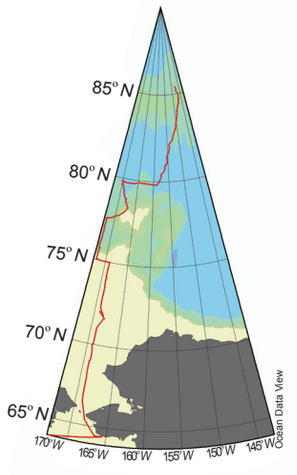
absorbing ability of the Southern Ocean is weakening.

The CO_2 partial pressure (pCO_2) in surface sea water of the Southern Ocean obtained through actual observation in February 2008 indicates more complex sea-air carbon flux pattern and variation, which reveals the variability and complexity of CO_2 absorption across the whole Southern Ocean. The following findings are suggested:

① Surface pCO_2 of the Southern Ocean shows great annual and seasonal variation, but the pattern of surface ocean carbon budget is basically stable on the regional level.

② With the increase of CO_2 concentration of global atmosphere, pCO_2 in the surface water of the Southern Ocean also rises on a general basis and at a higher rate than pCO_2 in the atmosphere. Its CO_2 absorption ability from the atmosphere is on the decrease.





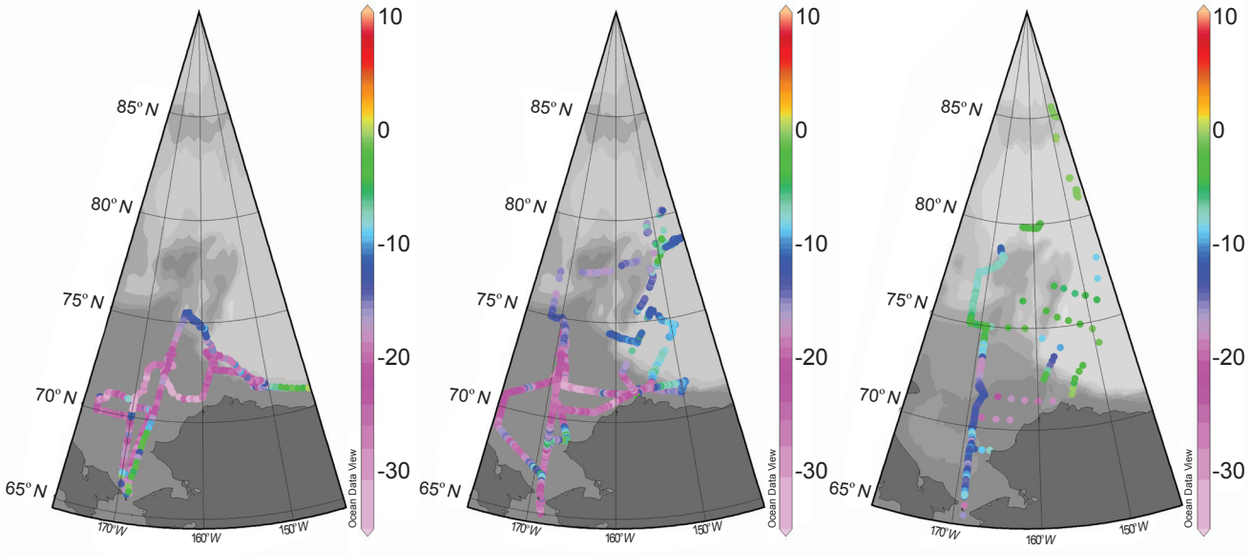
■ *Fig.18.4 Left: variation of distribution of pCO_2 along a latitudinal profile from the Bering Sea to 85.5°N of the Arctic Ocen in 2008 ; Right: Navigation route of R/V Xuelong from 85.5°N to the Bering Sea between Aug 29 to Sep 9, 2008*

(2) Changes of CO_2 absorption by the Arctic Ocean in the last ten years and its response to rapid changes in the Arctic

During our Arctic expedition, it was found in our observing area that (see figure 18.4) summer sea ice was melting rapidly due to the rapid Arctic warming. Last 10 years' observation shows that open water in the Arctic Ocean has kept expanding due to rapid melting of Arctic sea ice; the primary productivity increased due to sea ice coming from the coast and the continental shelf. These factors, combined with input of water with high nutrients and low pCO_2 from the Bering Sea, accelerates the biological pump, and the observing area has become a CO_2 sink (figure 18.4).

The observation data obtained during Arctic survey in 2008 shows that the pCO_2 of surface sea waters originally covered by the Arctic ice field was lower than atmospheric pCO_2 value, which means such waters are a potential sink for atmospheric CO_2. The newly opened water area could increase the absorption of atmospheric CO_2 and to a certain degree slow down global warming. (Fig. 18.5)

The newly melted area in the Canadian Sea Basin shows strong ability for atmospheric CO_2 absorption; on the other hand, with retreat of sea ice and the area of floating ice transforming into open water, absorbing ability of waters which melted earlier has begun to decline. This is probably because after long exposure to sun radiation, rise of surface sea water temperature of the ice-free open waters



■ *Fig. 18.5 Variations of carbon absorption flux(mmol C/m^2.d)in west Arctic Ocean during 1999, 2003 and 2008*
(a) for 1999, (b) for 2003 and (c) for 2008

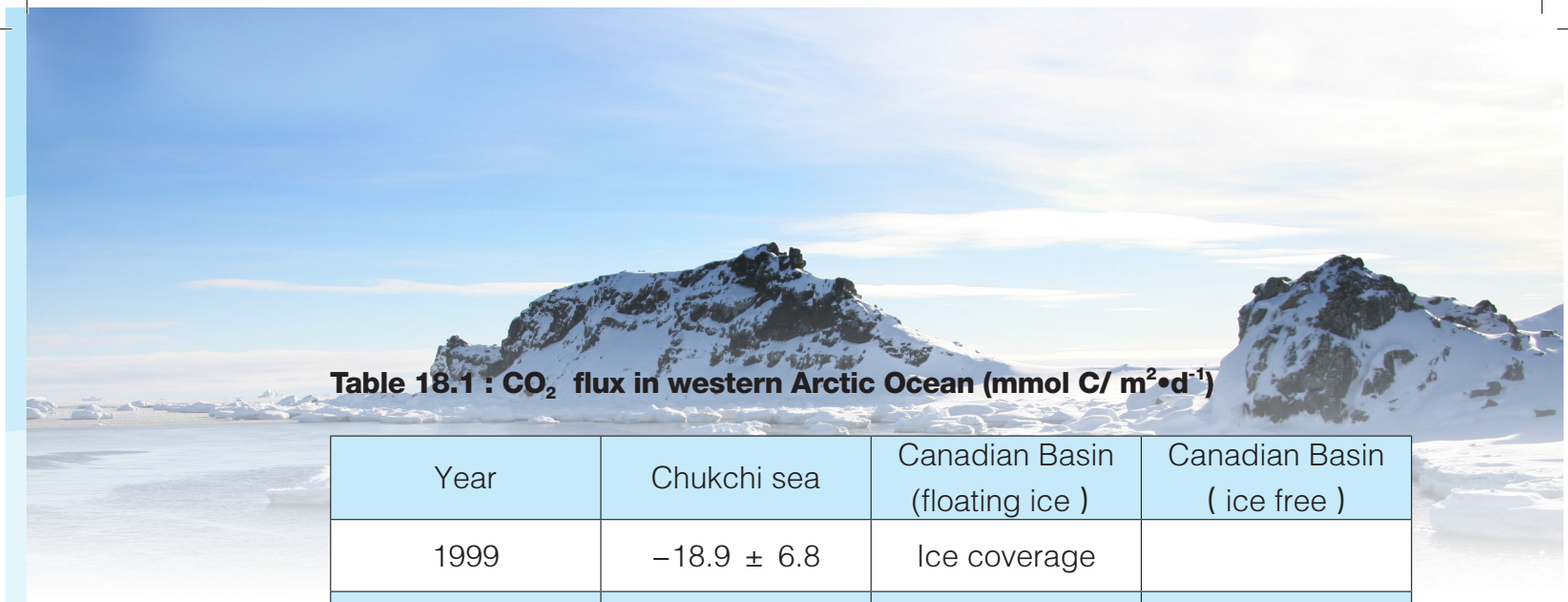


Table 18.1 : CO_2 flux in western Arctic Ocean (mmol C/ $m^2 \cdot d^{-1}$)

Year	Chukchi sea	Canadian Basin (floating ice)	Canadian Basin (ice free)
1999	−18.9 ± 6.8	Ice coverage	
2003	−18.2 ± 7.0	−14.0 ± 2.7	
2008	−16.5 ± 4.4	−10.4 ± 1.6	−3.6 ± 2.3

enhances its physical pumping effect and reduces its biological pumping function.

During the last 9 years, the absorptive capacity for CO_2 of per unit area in the Arctic Ocean has been on a declining trend, just like what happened in the Southern Ocean (table 18.1). But with the high productivity of the Chukchi Sea, such declining trend is not obvious. However, in the oligotrophic Canadian Sea Basin where productivity is low, this weakening effect becomes obvious. Due to the rapid changes of sea ice conditions in the Arctic, the Arctic carbon absorption areas increase rapidly and the ice free period becomes longer, which is favorable to CO_2 absorption. Therefore the ability of carbon absorption of the Arctic Ocean is increasing on an overall basis.

(3) The vulnerability of the South Ocean and Arctic Ocean as carbon pools

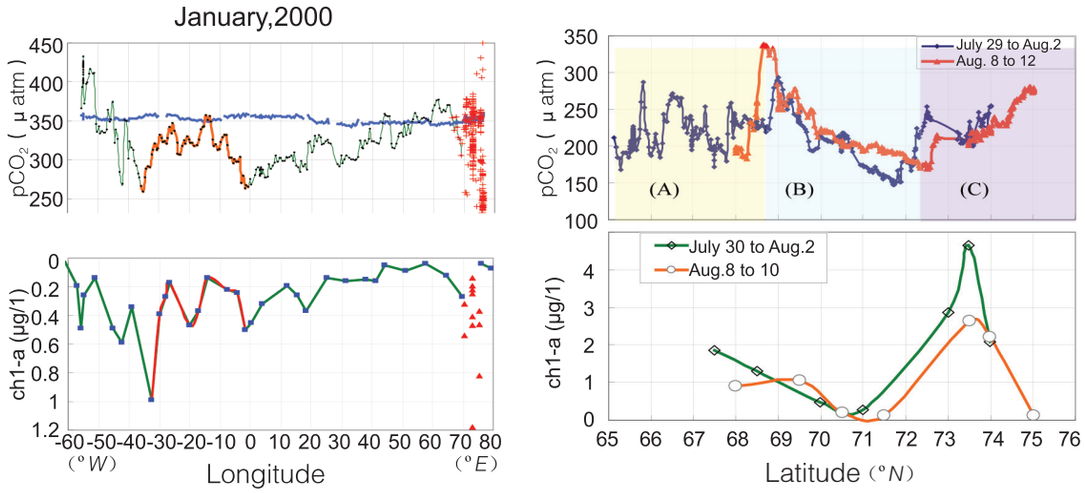
In the ocean-carbon-climate system, the vulnerability of the polar ocean carbon pool mainly comes from rapid changes of sea ice, ocean warming, increased vertical stratification, increases of west wind belt in Southern Ocean and the trend towards the pole, intensified variations of biological pump function and ecological system. The changes in the Southern Ocean is relatively smaller compared with that of the Arctic Ocean. The sea ice coverage in East Antarctica increases and in West Antarctica it decreases. Changes of sea ice coverage demonstrates an interdecadal seesaw pattern between the Pacific sector of Eastern Antarctica (increasing) and the Weddell Sea area of Western Antarctica (decreasing). Therefore, when analyzing CO_2 pool vulnerability of polar ocean areas, we must examine the differences in sea surface distribution pattern of CO_2 between the two polar regions and the driving factors that govern such differences.

(4) Differences of distribution pattern of sea surface CO_2 in the Southern Ocean and the Arctic Ocean

The analysis on the distribution of surface sea water pCO_2 and it main control factors show that in summer season with high productivity, both the Southern Ocean and the Arctic Ocean develop into significant atmospheric CO_2 sinks, but their distribution characteristics and main control factors are significantly different. In the Southern Ocean, biological effects in summer usually develop into the main control factor for pCO_2 distribution; on the whole, the pCO_2 distribution is negatively correlated to productivity.

The underway sea ice survey from the Great Wall Station to the Zhongshan Station (60ºW~80ºE) shows the coincidence of CO_2 source/sink distribution pattern and the distribution of chlorophyll. The distribution patterns in December and January are almost identical; pCO_2 declines significantly in January when productivity is higher, which reveals the biological controlling function and influence. In Prydz Bay, pCO_2 is almost entirely controlled by biological process and the pCO_2 and chlorophyll distribution show a clear negative correlation, making the bay a strong CO_2 sink .

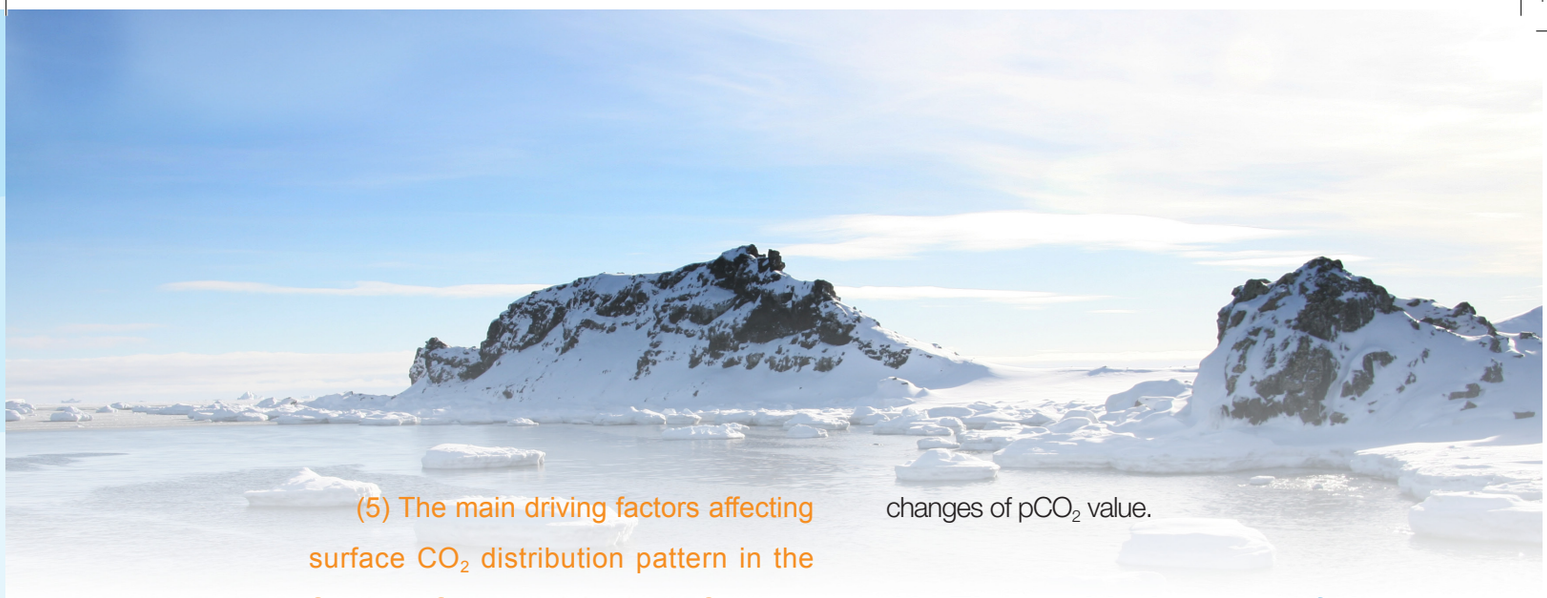
In the Northern Hemisphere, the pCO_2 distribution in summer in the Arctic Ocean is not simply correlated to biological productivity, but is affected by many factors. The control factors are very complex, and regional variations are obvious. The spatial and temporal pCO_2 variability to a large extent depend on the distribution of sea ice.



■ *Fig.18.6. difference of carbon cycle between the Southern Ocean and the Arctic Ocean: pCO_2distribution and control factors*

Upper: correlations between surface sea water pCO_2 distribution and chlorophyll distribution in the Southern Ocean.

Lower: distribution of pCO_2 and chlorophyll of the Chukchi Sea along 170°W profile



(5) The main driving factors affecting surface CO_2 distribution pattern in the Southern Ocean and the Arctic Ocean

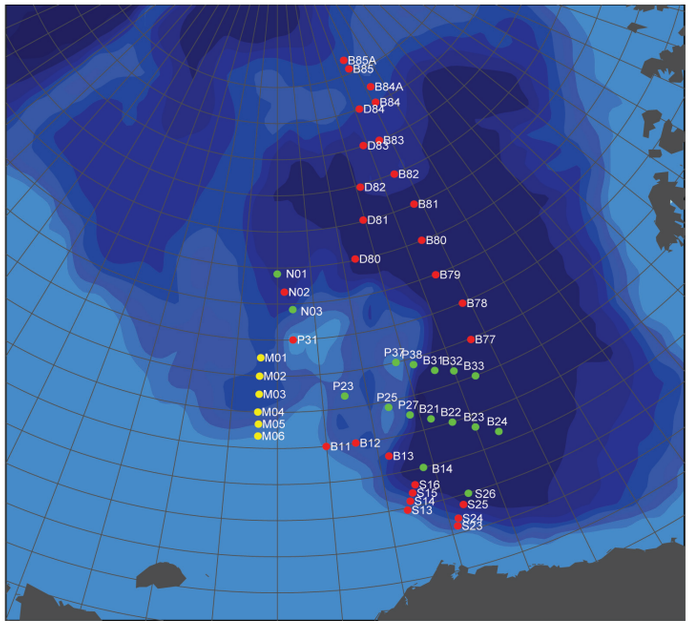
Comparison study shows that spatial-temporal variations of pCO_2 in the Arctic Ocean largely depends on sea ice distribution. In waters with greater sea ice coverage, pCO_2 value goes up with the increase of latitude, which might be due to changes of biological absorptive ability. In ice free areas (mainly on the Chukchi Sea continental shelf near the Bering Strait), pCO_2 values are significantly affected by two factors: biological pump function and water inflow through the Bering Strait. Because the Chukchi Sea has extraordinarily high biological productivity and the water inflow from the warmer Bering Sea and Alaska Coastal Current brings higher pCO_2 value, spatial and temporal distribution of pCO_2 in the Arctic Ocean is locally affected. Between the dense ice area and ice free area are broad marginal sea ice areas, where the pCO_2 values change with the temperature and salinity, all decreasing dramatically with the increase of the latitude, which reveals that ice melting plays a major governing role in changes of pCO_2 value.

19. The rapid changes of the Arctic Ocean and its sea ice

Project executor: Polar Marine Processes and Global Change Key Laboratory, Ocean University of China

(1) Spatial distribution of the depth of Arctic intermediate waters and their ascending movement in the Canadian Sea Basin

Analysis shows that Arctic intermedi-



■ *Canada Basin Arctic mid rise and fall of water distribution stations*

Red point increase in the cooling zone for cooling down the Green Point area, yellow spot for the initial position of water masses

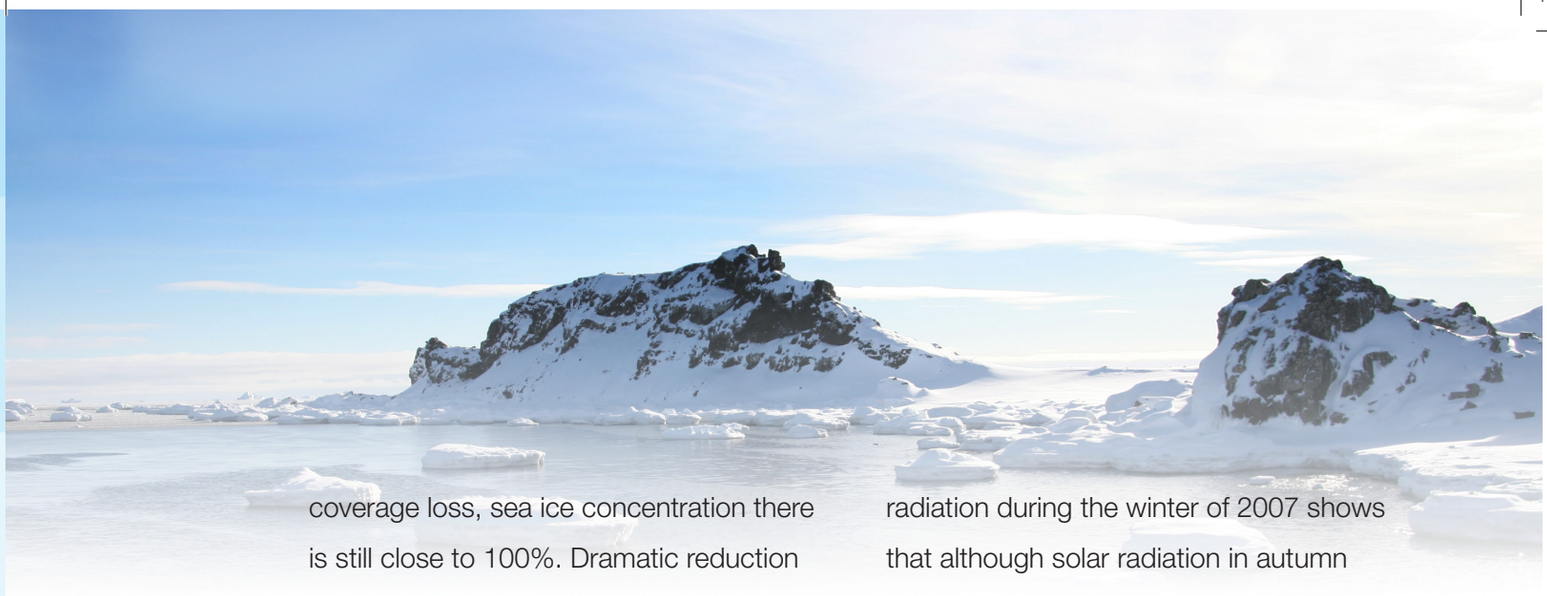
ate waters are transported in two ways after coming into the Canadian Sea Basin. One way is that the waters sink down after cooling and flows around the Chukchi Plateau, then flow away from the plateau and enter the southern part of the Canadian Sea Basin, as were concluded by previous researches. The temperature change of the descending cooled waters is limited, which shows that the Arctic Circumpolar Boundary Current is a fast transport channel. Another way is that the waters ascend while cooling, i.e., the intermediate waters cool down as they are transported, but the depth decreases. Such mode appears extensively in the northern part of the basin and also appears on the Chukchi continental slope.

The ascending movement of the Arctic intermediate waters in the Canadian Sea Basin is related to the upwelling current. It compensates for the vacancy left by the upper transpolar current flowing out into the Atlantic Ocean. As shown by depth changes of the intermediate waters, the ascending movement from the northern part of the Chukchi Plateau to the Alpha Ridge is the main compensation mode. Analysis on the ascending of intermediate waters over Chukchi continental slope shows that waters there may come from within the Chukchi Plateau, then flows to the continental slope; there is no significant upwelling current.

In the Canadian Sea Basin, there is not only the cool-and-descend transport mode for Arctic intermediate waters, but also a cool-and-ascend mode. The ascending movement in the Canadian Basin is the main form of movement for Arctic intermediate waters; it plays an important role for the mass balance of the Arctic Circumpolar Boundary Current and the the Canadian Sea Basin.

(2) Absorption of solar shortwave radiation by high ice concentration areas in the central part of the Arctic Ocean

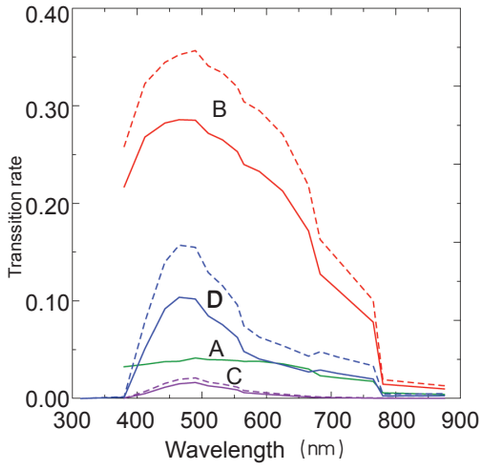
Eight-day optical observation on sea ice was carried out in August of 2008. The analysis on the obsorption of solar shortwave radiation by sea ice in the central part of the Arctic Ocean shows that: an average of 16% of the total shortwave radiation reaching the ice surface was absorbed by sea ice; 77% was reflected by the sea ice and only 7% of the shortwave radiation entered sea water. As time of cloud/fog coverage is particularly long in the high ice concentration areas, solar shortwave radiation was reduced by 57%. Observational result and theoretical calculation show that during the observation period, the solar shortwave radiation power absorbed was about 10.2Wm^{-2}, enough to melt 2.6 mm of sea ice each day; it would take 380 days to melt ice with a thickness of 1-m. The central area of the Arctic Ocean is covered by ice all year round and even amidst the current ice



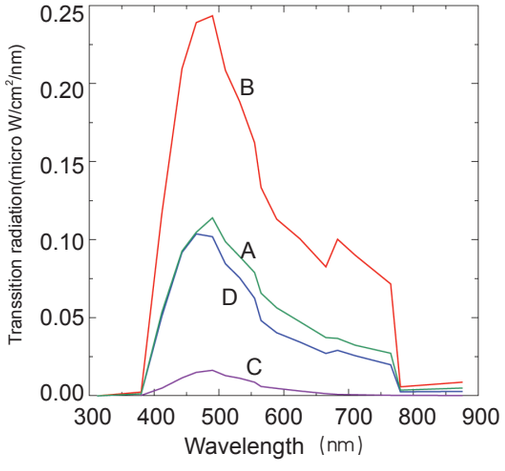
coverage loss, sea ice concentration there is still close to 100%. Dramatic reduction of the sea ice may be due to: a. the absorption rate of the solar shortwave radiation by sea ice may increase by 3 times if the cloud and fog decrease greatly; b. factors such as melting of overlying snow, decrease of ice thickness, increase of the number of polynyas may cause reduction of sea ice albedo, so more radiation energy may enter sea water; c. the increase of polynyas may cause rapid melting of the sea ice.

(3) solar radiation transmission through sea ice under the condition of low solar altitude

Observation data of transmitted radiation during the winter of 2007 shows that although solar radiation in autumn is weak, still a rather high proportion of solar radiation enters the ice or seawater, to some degree affecting the freezing rate of sea ice. When there is overlying snow, albedo of the snow surface does not change significantly with wavelength and remains basically a constant, while ice surface without snow coverage has strong long-wave absorbing ability and the albedo would decrease with the increase of wavelength. The 490nm light again takes the dominant position in the spectrum of transmitted radiation. At site BStation, a minor peak appears at 683nm



■ *Solar radiation transmission rate Stationwith snow coverage*



■ *Spectral distribution of transmitted radiation at the sites (solid line: with snow coverage; dotted line: without snow coverage)*

in the spectrum of transmitted radiation, but his peak did not appear for other sites. The observation shows that light with longer wavelengths is significantly attenuated while passing through sea ice and the thicker is the ice, the stronger is the attenuation..

(4) Extraction of information on polynyas in the Bering Sea based on grayscale-morphology

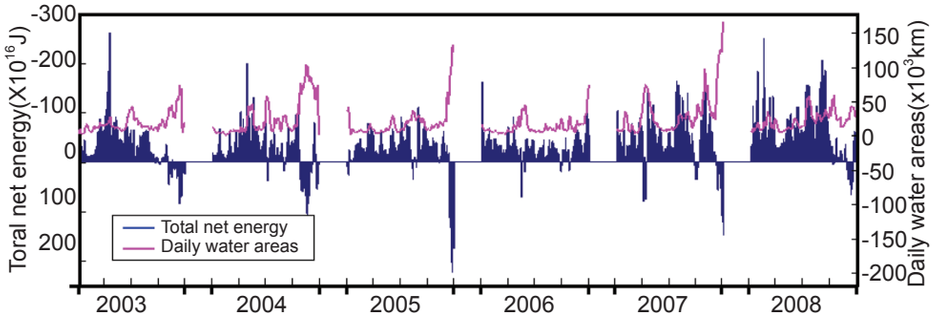
Based on the analysis of AMSR-E daily average sea ice concentration data for the Bering Sea during Jan.-Apr. of 2003-2008, the daily average polynya area's evolution with time in high ice concentration areas is obtained. This was compared with the daily average polynya area calculated through the 75% threshold method and their correlation coefficient was found to be 0.74, proving to be a continuous, consistent and comprehensive way to reflect areas of polynya waters.

Analysis of intra-seasonal variation of monthly average polynya water area shows that the smallest water area appears in January; the area remains almost unchanged in Feburary and March; the largest area appears in April. In addition, the year of 2007 had the largest January-April total polynya water area, which is consistent with the finding that summer of the same year had the smallest Arctic sea ice area.

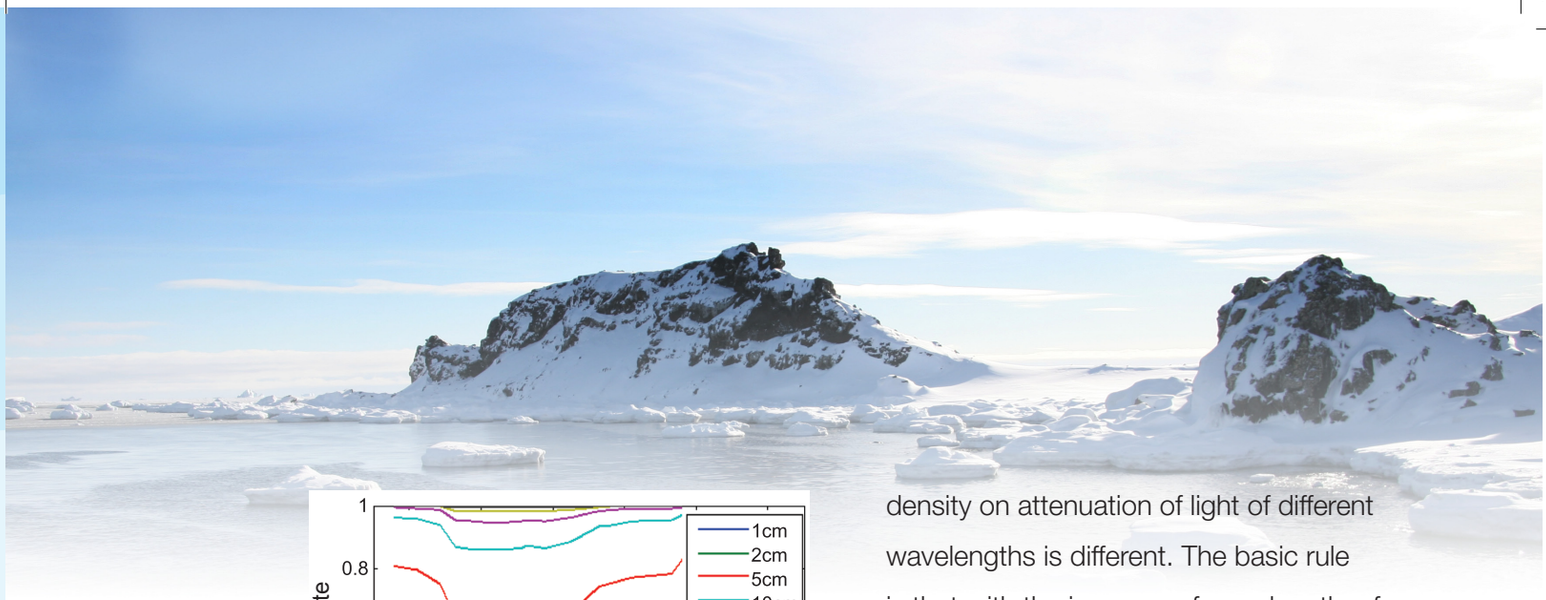
Sea-to-air energy release from January to March each year was obtained through calculation of heat flux of polynya water surface. Most of the heat loss occurred by way of sensible heat exchange, which amounted to 2 to 3 times of latent heat exchange and long wave radiation; as solar radiation became stronger and temperature rose up in April, sea-to-air sensible heat flux significantly decreases and net surface heat flux was close to zero; sea actually gained energy in certain years.

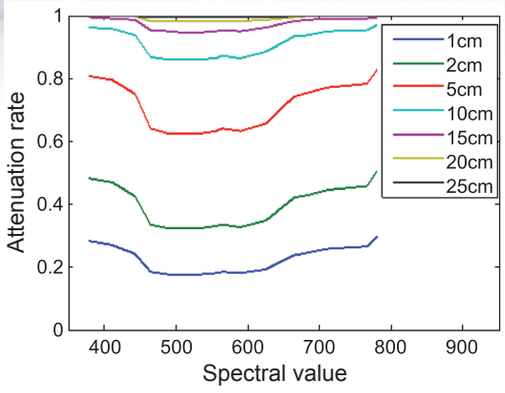
(5) Study on optical attenuation properties of snow on ice

The experiment of optical properties for snow on ice in Amundsen Bay of the Arctic was carried out from November of



■ *Blue line: net daily open water area Red line: total heat output of polynyas*





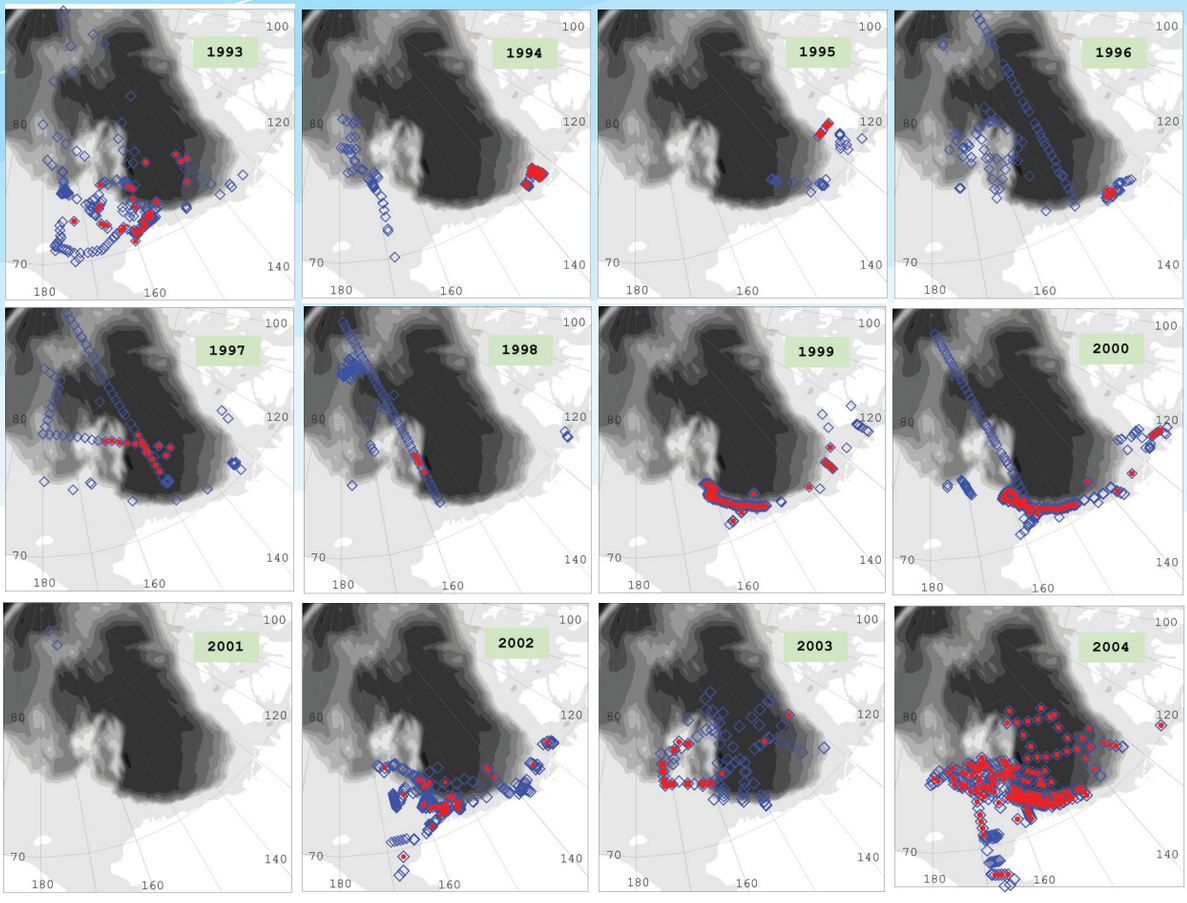
■ *Changes of attenuation rate through snow of different depths with wavelength*

2007 to February of 2008. The result shows that perpendicular incident light had rapid exponential attenuation through overlying snow at a rate much higher than that in the seawater. When light penetrates 10cm thick snow, the attenuation rate is more than 90%, but when light of different wavelengths penetrates through snow of the same thickness, its attenuation rate is different. This experiment found that snow has the smallest attenuation coefficient for green light at the wavelength of 532nm .

The results of 12 measurements with different snow density reveal that the larger snow density is, the greater attenuation is, i.e. the larger attenuation coefficient snow has. And effect of snow density on attenuation of light of different wavelengths is different. The basic rule is that with the increase of wavelength, effect of snow density on attenuation coefficient also increases.

(6) Sub-surface warm water and its forming mechanism in the Canadian Sea Basin

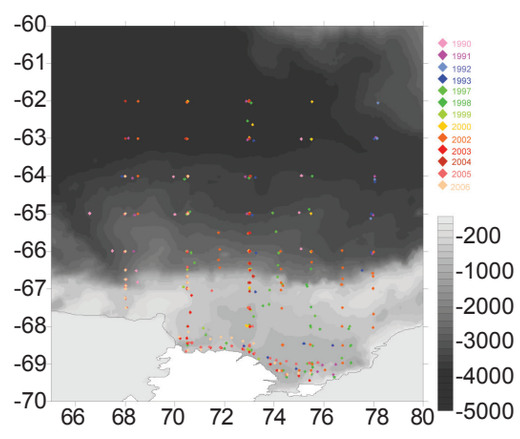
Chinese and international observation data obtained during 1993-2008 show that the sub-surface warm water could be observed in all these years in the Canadian Sea Basin. However, the areas it occurred were significantly different from year to year. Overall, in 1995, 1996 and 1998, when ice extent was larger, the area where sub-surface warm water could be found was very small. Observations show that forming of sub-surface warm water is based on three factors: a. cold water under ice; b. heating by solar radiation; c. surface cooling. In the Canadian Sea Basin, when winter convective mixing is dominant, sea ice would crack, allowing solar radiation to enter the sea and heat up seawater; sea ice cools the water, resulting in the formation of sub-surface warm water.



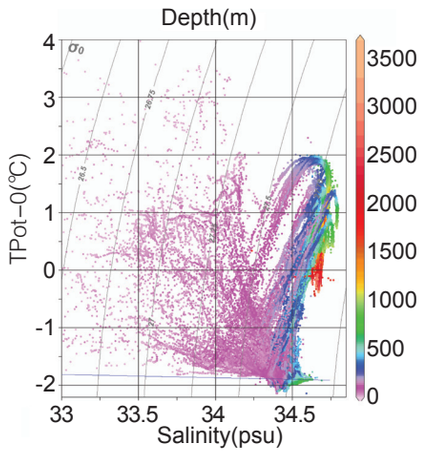
20. The nature and changes of water masses in Prydz Bay

Project executor: Polar Marine Processes and Global Change Key Laboratory, Ocean University of China

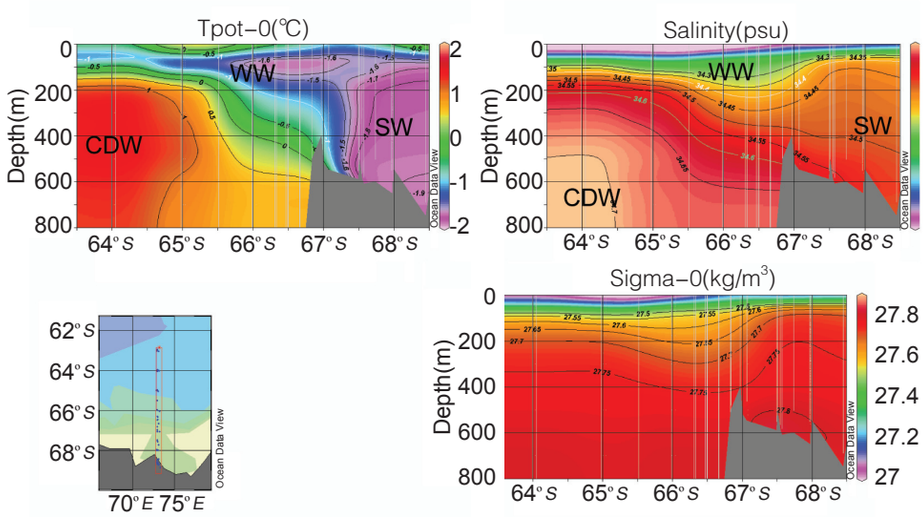
CTD measurements were conducted during 13 voyages between 1990-2006. The measured data is used to analyze the characteristics of the water mass in Prydz Bay. The analysis shows significant inter-annual variation of the surface sea water(SSW) in summer time; however, the warmest and thickest SSW appears in the southeastern area of the Bay, i.e. waters at the front of the Amery Ice Shelf. The maximum temperature used to often appear on the surface, but in the last few years, the maximum temperature was more often observed at the layer of subsurface sea water, i.e. the special structure of sub-surface warm water was observed. The changes of SSW is closely related to the changes of sea ice and polynyas. Ice shelf water, which is of particularly low temperature, is normally concentrated in waters at the front of the Amery Ice Shelf



■ *CTD stations in Prydz Bay*



■ *θ–S map based on data with acceptable quality*

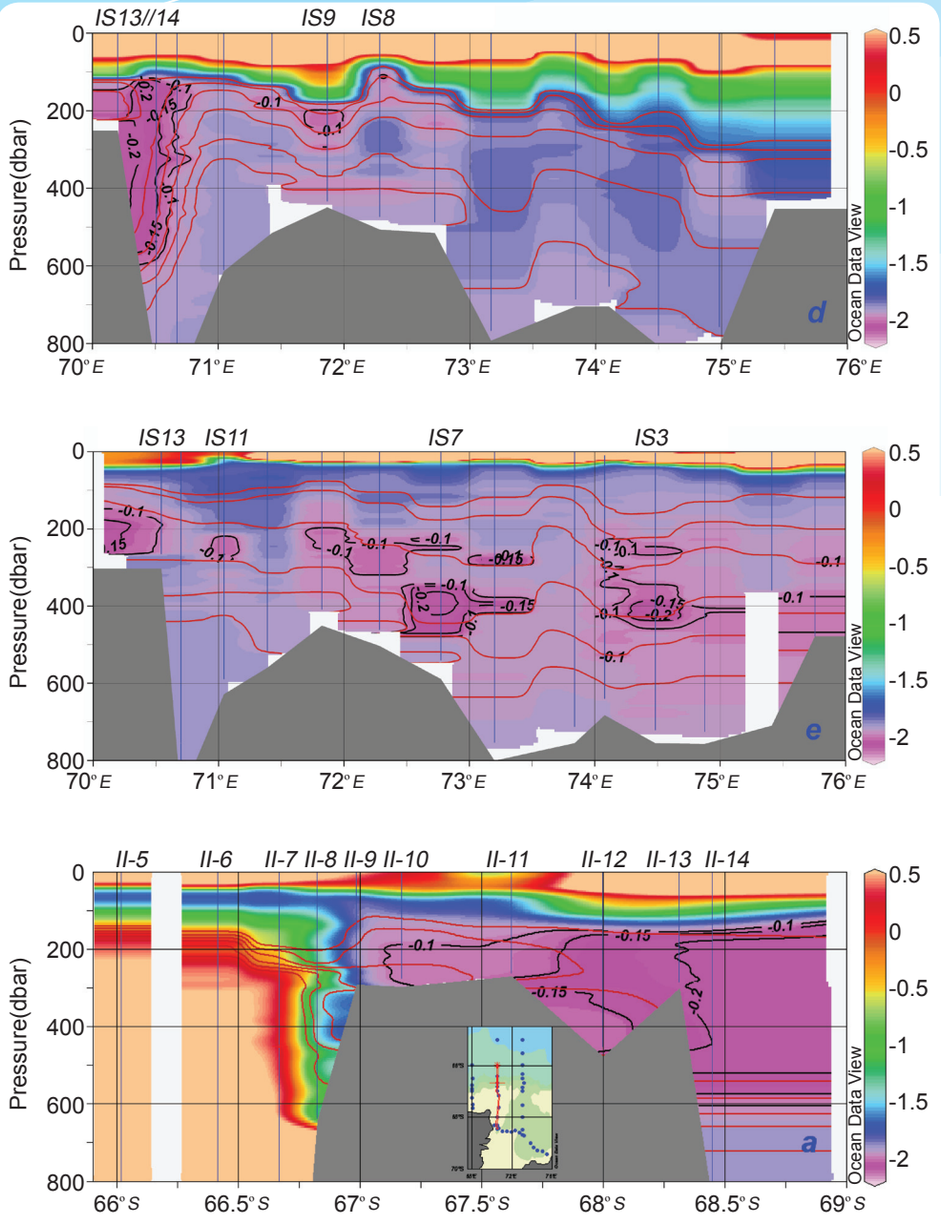


■ *Potential temperature, salinity and potential density maps based on data collected along the 73°E profile*

21. Study on ice shelf water in front of the Amery Ice Shelf

Project executor: Polar Marine Processes and Global Change Key Laboratory, Ocean University of China

Ice shelf water was observed on all survey profiles during the 6 summer seasons from the year of 2001 to 2008. Compared with other continental shelf water masses, ice shelf water has the characteristics of having relatively low but stable temperature and salinity. Only at the western end of the survey profiles could ice shell water be found to reach the bottom in all years. The ice shelf water in horizontal direction demonstrated several discontinuous central areas. The number and locations of the central areas show intra-seasonal changes and were different from year to year.



■ *Potential temperature, supercooling temperature and salinity profiles*

Color-scale area: potential temperature;

Black line: isothermal line for supercooled water (°C);

Red line: isohaline; the minimum value is 34.4, and the maximum value is 34.5, with an interval of 0.02;

Blue line: observing stations and observing layers;

Top: surveying profile in front of the Amery Ice shelf of 2003

Middle: surveying profile in front of the Amery Ice shelf of 2005

Bottom: 70.5°E Longitudinal profile (red line in the embedded map indicates location of the profile)

(IV) Academic Activities of the Key Polar Labs

1. Polar Science laboratory, SOA

The Polar Science Laboratory (hereinafter referred to as laboratory) held the first conference of the second academic committee. The conference established the guiding ideology and principles for future scientific development with the goal to be a national key laboratory.

In 2009, the laboratory undertook 93 research projects; nearly 100 papers were published on academic journals both at home and abroad.

The lab sponsored Polar Science Workshop 2009 with the theme of "Polar Climate, Remote Sensing and Numerical Prediction". More than 40 young scientific researchers and graduate students from the State Oceanic Administration, Chinese Academy of Sciences, and various universities attended the workshop.

2. Key Lab of Global Change and Marine-Atmospheric Chemistry, SOA

(1) Sino-US work group meeting on carbon cycle in the polar regions

Operation of the pCO_2 observing system fixed on R/V Xuelong was reviewed at the meeting and views were exchanged on how to improve the pCO_2 observation system. Discussion was made on technology improvements for pCO_2 observation and data processing, and academic exchanges was made on carbon cycle in the polar regions.

(2) PAG Arctic carbon integration and Sino-US carbon cycle operation work group meeting

The PAG seminar on Arctic marine carbon cycle and integration was held with the purpose of integrating the research achievements and all research results for publication. The experts attending the seminar exchanged their research results on carbon cycle in the western Arctic Ocean and the northwest Pacific Ocean and discussed the way and content of achievements to be integrated for publication.

3. Ocean University of China-Chinese Arctic and Antarctic Administration (CAAA) Joint Polar Research Laboratory

A joint Arctic survey project was discussed with Professor Michael Steele from Washington University; meeting was held with Professor Jackie Grebmeier from Maryland University for applying for a project; cooperative study on satellite sea ice remote sensing would be conducted with Dr. Xie Hongjie from Texas Tech University.

4. University of Science and Technology of China-China Arctic and Antarctic Administration Joint Lab of Polar Ecology and Geology

The 4th session of the second academic committee of the lab was held on November 1, 2008. The meeting discussed and evaluated the progress of some projects, such as ecological geology and global change, atmospheric environmental chemistry, soil environmental chemistry and ecological environment pollution and restoration.

5. Chinese Antarctic Center of Surveying and Mapping, Wuhan University

The Key Laboratory of the State Bureau of Surveying and Mapping for Polar Surveying and Mapping Science held its annual academic conference at the end of 2008 in Harbin. Professor Huang Jinwei from the Department of Civil Engineering of Taiwan Chiao Tung University was invited to deliver lectures at the lab and scientists of the lab were sent to Chiao Tung University for academic exchanges; scientists were also sent to Amsterdam to attend an international seminar cosponsored by SCADM and SCAGI of SCAR.

(V) Polar Science Strategic Research Foundation

To promote the development of polar science, China Arctic and Artarctic Administration has established China Polar Science Strategic Research Foundation on the basis of social donation. The foundation provided financial support to 19 projects in 2006 and 36 projects in 2007. In 2008, 67 applicant projects for foundation support were submitted and finally fundings were granted to 26 projects.

Evaluation has been carried out by an expert group organized by CAAA on completed projects approved in the year of 2006. The"Applications of Molecular Cloning and Expression of Cold-adapted Polar Microorganisms" program jointly conducted by Polar Research Institute of China and Shandong University had preliminarily revealed the function of PPC domain for the bacteria to adapt itself in the sea ice environment through the study of β - galactosidase and metalloproteinases of M4 family in low temperature environment. Part of the research results have been published in the Journal of Biological Chemistry . 14 projects in 5 categories carried out by young scientists such as study on polar microorganism and its metabolites; study on Antarctic ice algae; study on Antarctic planktons and biological silicon; study on Antarctica geological remote sensing and pollution monitoring were well appreciated.

(VI) Information and Data Services

1. polar scientific data sharing platform (www.chinare.org.cn),

41 data sets have been added to the Polar Scientific Data Platform this year, among them 16 data sets were for glaciology. By November 2009, 399 metadata and 992 data files and 6907M of data in 9 scientific disciplines are available for online sharing for researchers at home and abroad to use.

2. Polar specimen resource sharing platform (http://birds.chinare.org.cn)

The polar specimen resource sharing platform has been completed this year. Customizable search in English and Chinese is provided. By November, 2009, 5, 987 specimens and 9, 913 specimen pictures were available online.

3. Improvement of www.polar.gov.cn information service

Based on China's action plan under IPY, the "Database of Air-Ice-Sea-Ice Shelf Information for Eastern Antarctica", "the Arctic Ocean Oceanographic Database" and "Database on Solar Terrestrial Physics-Aurora Observation and Research" were established. They have become an portal to data and information service for polar scientific research. As a platform, it has provided an effective support to multi-disciplinary science research.

4. Improvement of http://908.chinare.org.cn information service

Data and information service on navigation route, virtual conditions in the polar regions, meteorological conditions in the polar regions. Intergrated products on certain subjects have been etablished and information service can be provided to scientific research.

5. Improvement of http://ecology.polar.gov.cn information service

The platform has been basically etablished, experimental equipment has been put in place, and data information resources have been put into service.

6. Antarctic meteorites management system

The comprehensive management system for meteorites has been established and effective management of 9,834 pieces of Antarctic meteorites has been

carried out. Sample service could be provided to scientists.

7. Management and coordination of field investigation data of 25th Antarctic Expedition

The large amount of data and information collected during the 25th Chinese Antarctic Expedition was classified into 31 categories. These data and information have been verified and archived, so that the data and information is ready to be released for people to use.

8. Publishing of polar periodicals and archiving services

Academic science journals “Polar Research” and “Chinese Journal of Polar Science” were published in six issues, on which 59 scientific papers concerning oceanography, biology, sediments, atmospheric science, upper-air physics and informatics were published. For the Polar scientific expedition and logistic support, 60 volumes of files and 15 CD-ROMs were provided for service.

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IV. Logistic Support

(I) Platforms for the Polar Programs

There were 9 construction engineering projects for Antarctica base construction, among them 4 projects for the Great Wall Station and 5 for the Zhongshan Station.

1. Upgrading and renovation of the Antarcitc stations

Great Wall SStation: 90% of the engineering projects for upgrading and renovation of the Great Wall Station has come to the ending stage, including: scientific research building, multi-functional center, boiler room and waste and sewage disposal house.

The old meteorology building, the old communications building, the old warehouse for the hazardous materials and old garage have been demolished, and the landform have been restored. The VSAT telecommunication and network system have been finished; computer network communication has been established between the Great Wall Station and the the domestic home base; Internet access from the Great Wall Station was established.

The Zhongshan SStation:

The upgrading and renovation of the Zhongshan SStation is a key part of the program for 2009. According to the plan, the iron and steel engineering structure for the garage, multi-functional building, special observing building, and waste and sewage disposal house have been basically finished. Besides, the base for

satellite antenna, HF radar room, lifting and fixing of the steel structures and the fixing of glass cover have all been finished. The VSAT satellite network and the computer network in the Station have been done, so that the expeditioners can have online communication with the domestic institutes.

2. Research Vessel Xuelong

T>Russia, so that the vessel would be better equipped and would play even more effective role in the logistic support and the field scientific research.

(II) Implementation of the Logistic Programs at the Stations

1. The Great Wall SStation

(1) Preparatory surveys for the Expeditioner Psychological Support System project

The expeditioners were investigated and compared in their cognitive function, ability in concentrating their attention and memory. The expeditioners of winter-over team were investi-

gated for their mood changes, immediate feedback control effect, factors causing emotional outbreak and the control strategies and methods and key factors affecting team morale and work performance during winter time.

(2) Surveys for the Monitoring-Based Safety and Health Precautionary System project

The Monitoring-Based Safety and Health Precautionary System is established on the basis of field records of potential risks, the expeditioners' behavior during their normal life in the Antarctic station, physical examination and their strength and endurance. The precautionary system includes sudden accident response mechanism, accident medical care measures, new medical security measures, heavier snow disaster prevention mechanisms, fire monitoring and prevention mechanism, safety measures for operation in non-ice sheet areas and mechanical operation security measures.

(3) Routine operations

Maintenance of mechanical installations including power generators, vehicles and machinery equipment, transportation equipment, plumbing system as well as the medical care and environmental protection have been conducted as a part of normal work.

2. The Zhongshan SStation

(1) Geological survey in the station area

The geological survey was conducted to better understand the geological features in and around the station area, which will be the geological basis for future engineering projects in the station. The surveying operation has been carried out on the foundations for the main building, the accommondation building, the power generating room, the oil tanks and the dam to be built on Lake Mochou. The survey undertaken was to measure the thickness of sediment and variation of bedrock and find possible watershed leakages.

(2) Routine operations

Maintenance of mechanical installations including power generators, vehicles and machinery equipment, transportation equipment, plumbing system, and efforts have been made to keep the environment of the station in sound conditions.

3. Logistic support operation of R/V Xuelong

R/V Xuelong departed from shanghai on Oct. 10 2008 and returned to shanghai on April 10,2009. It took her 173 days and sailed 25,402 nautical miles from Shanghai - Jeju Island-Fremagntle- the Zhongshan Station –Melbourn-the Zhongshan Station –Casey Station –the Zhongshan Station- Fremantle- Kaohsiung-Jeju Island then back to Shanghai.

R/V Xuelong worked as a marine platform for scientists to conduct oceanographic research in Prydz Bay, 5 profile surveys were conducted in addition to the logistic support to the Antarctic research.

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V. International Cooperation and Exchange

International Cooperation and Exchange

(I) International Conferences

1. Intergovernmental Meeting of Experts on Biological Prospecting in the Antarctic Treaty Area

The expert meeting was held February 2-3, 2009 in Baarn, Netherland. Representatives from 20 countries and 6 international organizations attended the meeting. Chinese representatives from China Ministry of Foreign Affairs and the Chinese Antarctic Administration attended the meeting.

2. The Arctic Science Summit Week (ASSW)

The summit was held during March 22-28, 2009 in Norway. Chinese delegation attended the conference. The conference focused on the legacy of the International Polar Year. The Chinese delegation exchange ideas with various international organizations and discussed with them how future cooperations are to be conducted.

3. the 32nd Antarctic Treaty Consultative Meeting (ATCM) and the 12th meeting of the Commission for Environmental Protection (CEP)

The 32nd Antarctic Treaty Consultative Meeting and the 12th meeting of the Commission for Environmental Protection were held during April 6 to 17, 2009 in Baltimore, United States. Some 300 representatives from 28 consultative parties, 11 non-consultative parties and 4 four observer states and 11 relevant international organizations attended the meeting. China's delegation with 6 people attended the meeting. Meanwhile, China's Ambassador to the US Zhou Wenzhong delivered speech at the meeting in celebration of the 50th anniversary of the Antarctic Treaty.

4. The ministerial conference of the Arctic Council and the "Melting Ice" conference

The ministerial conference of the Arctic Council was held on April 29, 2009, in Tromsø, Norway, and the "Melting Ice" conference was held on April 28 in the same place. Chinese delegation attended the meetings. The Tromsø Declaration was adopted during the ministerial conference of the Arctic Council, which including 9 parts concerning Arctic climate change, International Polar Year and its legacy and other aspects. The "Melting Ice" conference on the Arctic ice-melting decided to form an expert work group for timely report of ice-melting world-wide.

5. Changes in the Arctic Environment and the Law of the Sea Conference

The conference was held during May 20-22, 2009 in Alaska by University of Virginia. Representatives from the United States, Canada, China, Russia, Norway, Iceland, Denmark, Japan, Germany, Ukraine and Monaco attended the conference. Chinese delegation headed by Mr. Wu Jun, the deputy director of China Arctic and Antarcitc Administration attended the conference. The Arctic sea waterway, the Arctic oil and gas resources, the Arctic Ocean environment and biodiversity issues were discussed.

6. KOPRI's 16th International Symposium on Polar sciences

The symposium, hosted by Korea Polar Research Institute, was held in South Korea during June 10-12, 2009. The symposium focused on two subjects: 1. Current interests and the latest progress and achievements in polar researches; 2. celebration of the expectd launch of South Korea's new ice breaker

R/V ARAON and discussion regarding possible future international cooperation based on the new vessel. A five-member Chinese delegation attended the meeting and visited ARAON.

7. Sino-US polar region carbon cycle research workgroup meeting

The meeting was held on 28 June 2009 in Xiamen, China. The pCO_2 observing technology and data processing were discussed, and technical exchange was conducted among the experts.

8. The Pacific-Arctic Group Arctic marine carbon cycle seminar

The Arctic carbon cycle seminar was held in Xiamen during 29 June to July 1, 2009. Some 40 scientists from United States, Russia, South Korea and China in North Pacific region attended the seminar. Representatives discussed the progress made in Arctic carbon cycle and future cooperation in this field.

9. The 10th Asian Forum on Polar Sciences

The forum was held during July 9-10, 2009, in Shanghai and 34 representatives from China, Japan, South Korea, Malaysia, India, Vietnam and other countries attended the meeting. Discussion was made on 4 topics. Progress and potential cooperation were explored.

10. The 21st COMNAP meeting

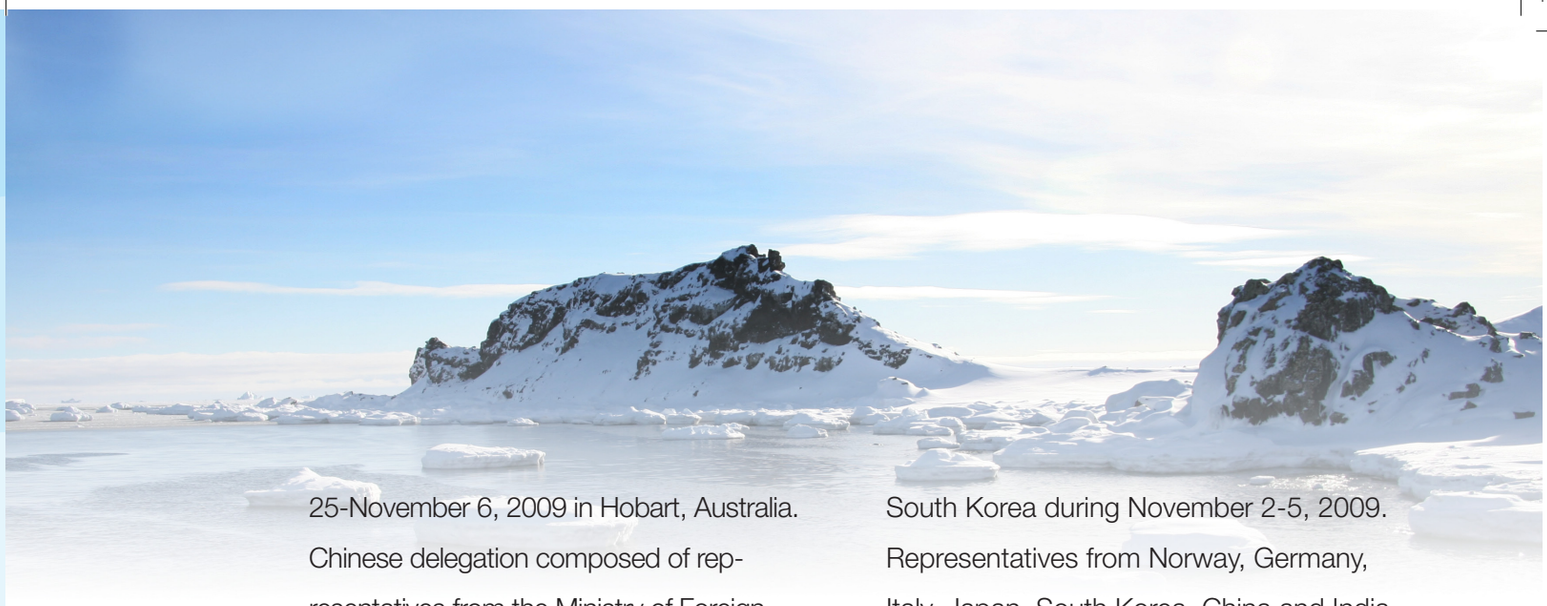
The 21st COMNAP meeting was held during August 3-6, 2009 in Chile. Representatives from 27 member states attended the meeting. Chinese delegation headed by Wu Jun, the deputy director of Chinese Arctic and Antarctic Administration attended the plenary meeting and related work group meetings. The logistic cooperation for research activities on King George Island and Fildes Peninsula was discussed. Extensive contacts were made among the member states to exchange experience and seek further logistic cooperation.

11. Arctic Council working group meeting on Arctic marine shipping

The working group meeting on marine shipping in the Arctic Oean was held during October21-24, 2009 in Alaska. The infrastructure construction group, the Protection of the Arctic Marine Environment Working Group (PAME) and vessels navigation group conducted discussions on their concerned issues. The proposals they drafted would be submitted to the Arctic Council for consideration as to whether it should be adopted as an action document of the Council.

12. The 28th meeting of the Commission for the Conservation of Antarctic Marine Living Resources

The 28th meeting of the Commission for the Conservation of Antarctic Marine Living Resources was held during October



25-November 6, 2009 in Hobart, Australia. Chinese delegation composed of representatives from the Ministry of Foreign Affairs, Ministry of Agriculture and the State Oceanic Administration attended the meeting. The meeting discussed the development, conservation and management of the fishery resources in the Southern Ocean. The Chinese delegation were active in the discussions on the agenda, promoted the protection and conservation of the marine living resources in the Southern ocean and maintained our stand and interests in the Southern Ocean.

13. The 31st Ny-Ålesund Science Managers Committee

The 31st NySMAC was held in Seoul, South Korea during November 2-5, 2009. Representatives from Norway, Germany, Italy, Japan, South Korea, China and India attended the meeting. The meeting proceeded with 17 issues on the agenda. The Chinese delegation introduced their progress made at the Yellow River Station and exchanged views and experience with representatives from other countries.

14. The Arctic Council Meeting of Senior Arctic Officials

The Arctic Council Meeting of Senior Arctic Officials was held during November 12-13, 2009 in Copenhagen, Denmark. Chinese delegation composed of representatives from the Ministry of Foreign Affairs, the Ministry of Communications, and State

Oceanic Administration attended the meeting. The meeting proceeded with extensive discussions on climate change, biodiversity, human development, marine pollution, data management, environmental protection and monitoring and the International Polar Year.

(II) International Exchange

1. Norwegian Minister of Research and Higher Education visited Polar Research Institute of China

Norwegian Minister of Research and Higher Education Tora Aasland visited the Polar Research Institute of China on November 7, 2008. Both sides expressed interest in further cooperation in scientific research on atmospheric physics in the Arctic region.

2. Japanese meteorite experts visited Polar Research Institute of China

Professor Hideyasu Kojima of Japan National Institute of Polar Research and Professor Makoto Kimura of Ibaraki University visited Polar Research Institute of China on November 7, 2008, and made an introduction of the progress on meteorite study in Japan. The two sides explored the possibility of future cooperation in meteorite study.

3. Canadian Minister of Indian Affairs and Northern Development delegation visited SOA

The Canadian Delegation, headed by Mrs. Danielle Labonte visited SOA on November 14, 2008. Future cooperation in scientific research in the Arctic was explored, and both sides showed interest in potential cooperation.

4. Chinese Delegation visited the stations on King George Island

Chinese Delegation headed by Li Haiqing, the Director of the General Office of SOA, visited the Great Wall Station and neighboring Stations on King George Island during January 6-8, 2009. During the visit, the delegation had broad contacts with the neighboring Stations and expressed willingness for further scientific and logistic cooperation.

5. Korea Maritime Institute scientists visited Polar Research Institute of China

Two marine scientists from Korea Maritime Institute, Mr. Kim Tae-Il and Mr. Park Mun-Jin visited Polar Research Institute of China on January 14, 2009. They had a very extensive discussion on cooperation in Arctic research. With the rapid melting of the Arctic ice, the Korean Maritime Institute, as a state-run research institution, has also stepped up relevant researches. Both sides expressed their interest in long-term cooperation.

6. Two marine scientists from Ocean University of China participated in American Bering Sea research cruise.

Two marine scientists from Ocean University of China participated in the cruise aboard USCGC Healy during March 10-31, 2009. The scientific project carried out by the two Chinese scientists is “Benthic Ecosystem Response to Changing Ice Cover in the Bering Sea (BEST)”. During the cruise, Chinese scientists with their American colleagues conducted research on marine optics study, physical oceanography study and study on marine biological processes under different ice conditions. Follow-up work will be continued after field investigation.

7. Sino-UK joint meeting on the Antarctic Dome A study

Sino-UK joint meeting on Dome A study was held during March 19-20, 2009, in Cambridge. The meeting was jointly sponsored by the British Antarctic Survey (BAS) and Polar Research Institute of China. A number of British scientists and 8 Chinese scientists attended the meeting.

Intensive discussion was focused on geophysics and glaciology. Scientists from both sides expressed their interests in future cooperation in theses scientific areas.

8. Chinese delegation visited Sweden

Chinese delegation headed by Mr. Wei Wenliang of the Chinese Arctic and Antarctic Administration visited Sweden and participated in the trial voyage of Swedish ice breaker Oden to the Arctic Ocean during July 13-17, 2009. After that the delegation visited some shipyards of Norway and Finland.

9. Researchers of Ocean University of China participated in Canadian Joint Ocean Ice Search (JOIS) cruise

Two marine scientists from the Ocean University of China participated in the cruise during September 17-October 15 2009. Their subject is focused on the attenuation of solar radiation through atmosphere and sea ice.

10. Staff training exchange

Staff training exchanges were made in 2009 between China and Japan as well as China and South Korea. China sent its winter team members to Japan and South Korea to participate in their winter training program; at the same time, China received the winter team members from both Japan and South Korea and for participation in China's winter team training programs.

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VI. Developments of key projects in 2009

(I) The construction of the Kunlun Station

The construction of the Kunlun Station (80°22′S, 77°21′E; elevation 4093m) on Dome A, east Antarctica was completed on 27 January 2009. The total construction area is 236 square meters, including living quarters, and science section. The station can hold 20 expeditioners to carry out scientific activities. The scientists can engage in scientific study on astronomy, geology, geophysics, atmospheric science, space physics and human medical research; in addition, scientists can take the station as a platform to carry out geomagnetic observation, satellite remote sensing data receiving and ice core drilling on the ice sheet. It is the ideal region for scientists to conduct many Antarctic scientific programs.

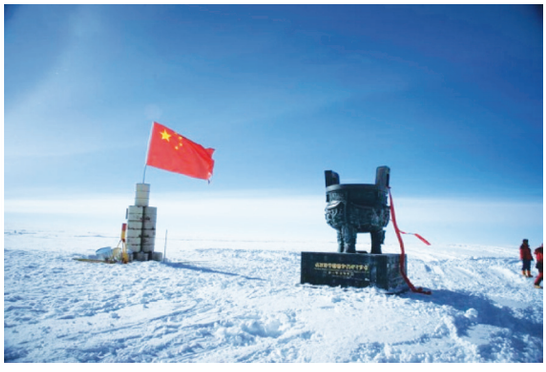
The Kunlun station on the Dome A is a milestone for China's Antarctic scientific activities, which shows that China has ability to push its scientific activities from the Antarctic coast area to the inland region.

(II) Upgrading and reconstruction of the Antarctic stations

1. The Great Wall Station

The planned upgrading and reconstruction area in the Great Wall Station is about 1792m^2. The engineering operation for the multi-functional center, the building for scientific activities, the house for sewage treatment, the house for waste disposal and a boiler room have been all completed.

The fixing of VSAT satellite antenna has been finished and it has been put into trail operation; the 8 oil tanks (88m^3 for each in volume) would be put in place during 2009-2019 austral summer sea-



son; the main engineering operation for sub-Antarctic eco-environmental dynamic laboratory as a platform for scientific research has been finished and the indoor finishing work would be carried out by the 26th Antarctic expeditioners.

2. The Zhongshan Station

The planned upgrading and reconstruction area in the Zhongshanl Station is about 3858.58m^2. The overall engineering operation is unfolding. The framework engineering for the multi-functional center, the physical laboratory, the garage, the general storehouse, the sewage treatment house, the waste disposal house has all been proceeding according to designing plan. The fixing of VSAT satellite antenna has been basically finished and it has been put into trial operation; the 12 oil tanks (55m^3 each) would be put in place during the 27th Chinese Antarctic expedition; advanced equipment and devices have been purchased for both “ice–snow/climate laboratory” and “Polar geo-space environmental laboratory”

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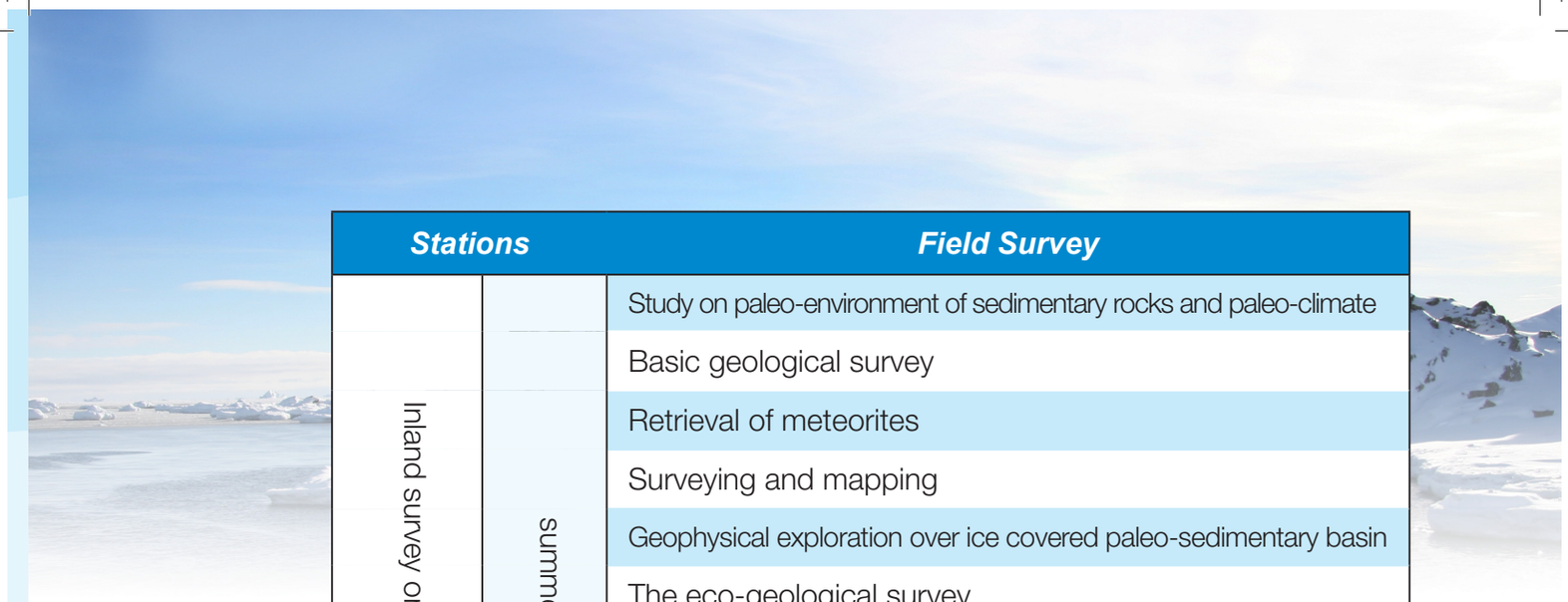
VII. The Polar Programs for 2010

(I) The Plan for Polar scientific activities

Stations		Field Survey
Great wall	winter	Routine meteorological observation
		Investigation and evaluation of cold-adapted microorganisms species and gene resources of King George Island
	summer	Special biomarkers and monomeric δ13C and δD sedimental record - impact of ENSO on phytoplankton changes and carbon cycle in southwest Antarctica
		Study on King George Island nearshore nutrient dynamics
		Upgrade and maintenance of GPS tracking station and GPS international campaign
		Exploration of long distance migration and source of new persistent organic pollutants in Antarctica
		The survey of typical new pollutants on King George Island
		Investigation of terrestrial lichen communities and sample collection for detection of heavy metal elements in the Great Wall Station and its surrounding area
		Eco-environment monitoring on Fildes Peninsula
		Deployment of nearshore marine environmental monitoring system
		The characteristics of persistent organic pollutants in Antarctic coast environment and decadal variation of persistent organic pollutants in guano layer
		Study on physiologically active substance contained in marine organisms
		Comparative study on Holocene environmental evolution of the ice-free area in the Great Wall Station
		Ecological environment baseline survey of the Great Wall Station

Stations		Field Survey
The Zhongshan Station	winter	Routine meteorological observation
		Ozone observation and aerosol sampling
		Upper-air physics observation
		Routine geomagnetic observation
		GPS year-round tracking and tide gauging
		Earth tide observation
	summer	The measurement of major ground surface covering spectra in Antarctica and circum-Antarctic underway sea ice survey
		The comprehensive sea ice survey in Prydz Bay
		Study on isotope tracing of lead contamination in the atmosphere of the Zhongshan Station
		Survey of Amanda Bay Antarctic Specially Protected Area
		Tide gauging stationStation at the Zhongshan SStation
		The field application study for polar robot systems in the Antarctic
		The Dalk Glacier glacial dynamics study and typical lake observation in Larsemann Hills
		The field investigation of Amery Ice Shelf
		Sea ice sampling and in situ analysis in Prydz Bay
		The monitoring of C, N and persistent organic pollutants in Antarctic atmosphere
		Study on physiological and psychological impacts on the expeditioners participating in Dome A expedition and Zhongshann winter-over
		Upgrading the monitoring instruments for Atmospheric background observation

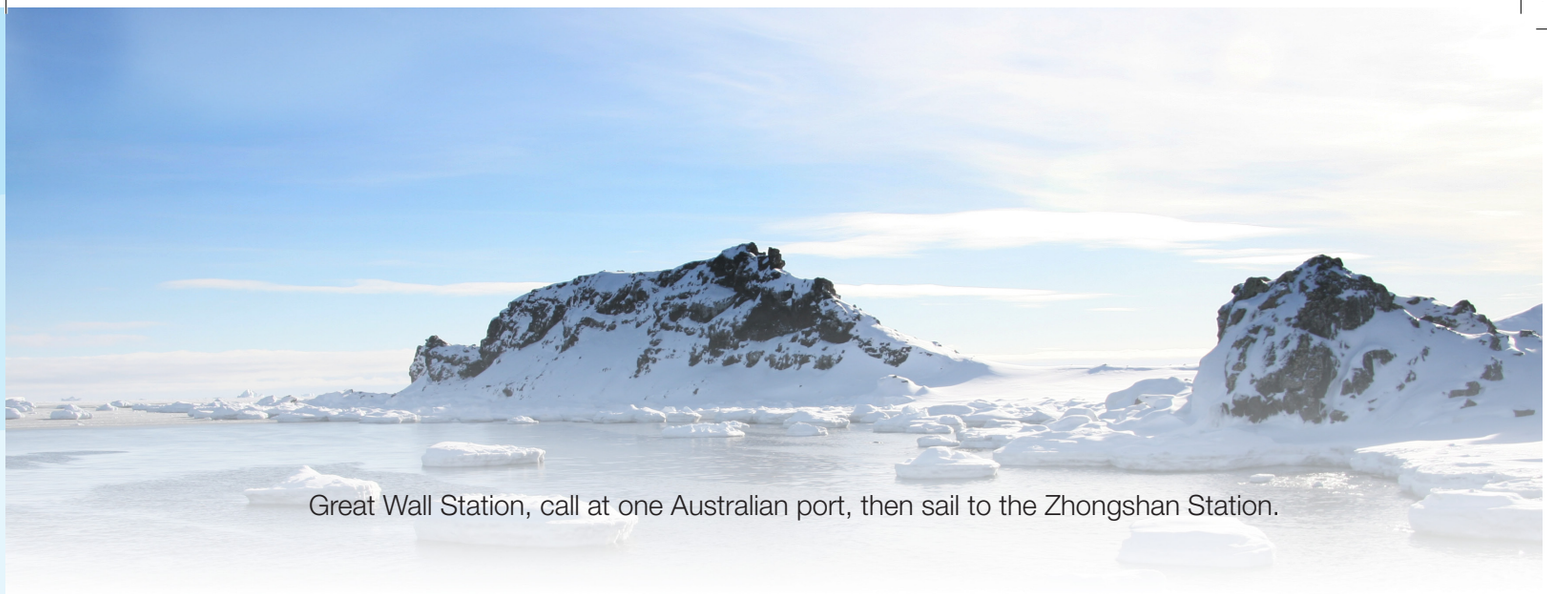


Stations		Field Survey
Inland survey on the ice sheet	summer	Study on paleo-environment of sedimentary rocks and paleo-climate
		Basic geological survey
		Retrieval of meteorites
		Surveying and mapping
		Geophysical exploration over ice covered paleo-sedimentary basin
		The eco-geological survey
		Glaciology survey between the Zhongshan Station and Kunlun Station
		Astronomy observation from the Zhongshan Station to Kunlun Station
		Survey and mapping between the Zhongshan Station and Kunlun Station
Southern Ocean	summer	Study on carbon flux and biogeochemical processes in Prydz Bay and adjancent seas
		Study on structure and biodiversity of pico-phytoplankton communities in the Southern Ocean
		Study on carbon flux over important interfaces in the Southern Ocean
		Study on N_2O latitudinal distribution in summer in surface water along the cruise route of R/V Xuelong
		Marine profile observation under sea ice in Prydz Bay
		Amery Polynya airborne XCTD deployment and aerial photogrammetry
		Permanent polynya observation with sub-marine mooring system in Prydz Bay
		Surface circulation observation with drifting buoys in Pradz Bay
		Isotopes marine chemistry
		The monitoring and evaluation technology for krill resources in the Southern Ocean
		The coordination, management and sharing of in situ observation data

Stations		Field Survey
Yellow river Station	Wint-er	The ionosphere observation in winter time
	summer	Verification of analysis method for heavy metal and organic pollutants in multiple environmental media in polar regions
		Lichen ecology investigation and the isolation and cultivation of symbiotic bacteria and symbiotic algae
		The spatial and temporal variation of flux of greenhouse gases and the affecting factors in tundra area of the Arctic
		geomicrobiology of Spitsbergen Island coal mine drainage water and its environmental effect
		Collection of sediment for fecal sterol and 13C analysis at the Yellow River Station
		The distribution characteristics and sedimentary dynamics of modern foraminifer in Kongsfjorden near the Yellow River Station
		Investigation of polar toxic species of animals and special microorganisms
		The ecological environment monitoring of the Arctic Yellow River Station
		The observational study on Arctic tundra near ground physical processes
		The monitoring study on modern glaciers and climate change in Svalbard region of the Arctic

(II) The Plan for logistic support activities

R/V Xuelong will provide logistic support to both the Great Wall Station and Zhongshan Station during the 26th Antarctic Scientific Expedition. The vessel will first sail to the



Great Wall Station, call at one Australian port, then sail to the Zhongshan Station.

1. Logistic supporting plan during 2010 season for three Antarctic stations

Details of logistic plan for three Antarctic stations		
	winter	*summer*
Great wall Station	Maintenance of power generating and power distributing systems	fix oil tanks
		Remove old sewage treatment house, the old incinerator, pipelines, and building No.2
	Maintenance of vehicles and machinery equipment	equipment installation and commissioning of ecological environmental laboratory
	Inspection and maintenance of plumbing system	Ground reception system for remote sensing satellite
		old building's painting
Zhongshan Station	Maintenance of power generating and power distributing system	Foundation for oil tanks, reconstruction of the multi-functional building and the complex storehouse
	Maintenance of vehicles and machinery equipment	Fixing of the H-frequency radar antenna
		Station Computer Network
	Inspection and maintenance of plumbing system	Ground reception system for remote sensing satellite
		Revising of the construction design
Kunlun		Field work for ice drilling
		Revising of the construction design

2. Navigation plan for R/V Xuelong

R/V Xuelong will depart from Shanghai on October 11, 2009 for Antarctica. On the way she will call at a port in New Zealand, then sail to the Great Wall Station. After unloading she will call at Ushuaia port of Argentina for loading fresh water, fuel and foodstuff, then it will sail to the Zhongshan Station. She will then carry out oceanographic investigation in the Southern Ocean, and will sail back and arrived in Shanghai in April, 2010.