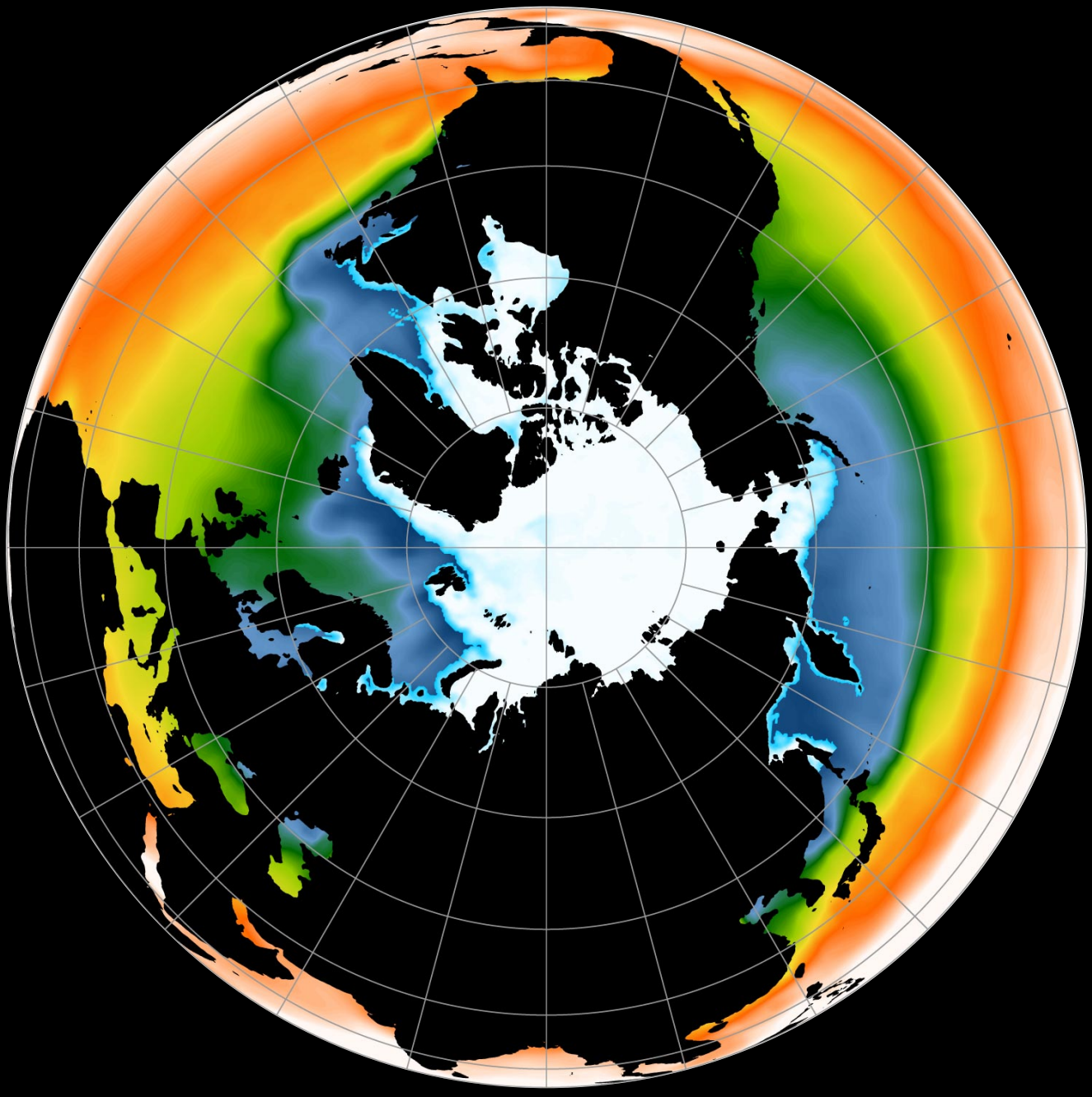
One Earth – one future

地球, 只有一个!



Annual Report 2004

Nansen-Zhu International
Research Centre
Beijing, China

Report from the board

Vision

The overarching goal of the Nansen-Zhu International Research Center (*NZC*) to become an internationally acknowledged climate research and training centre with emphasis on tropical and high-latitude regions, and the interactions between these regions, for past, present and future climate.

Organization

The *Nansen-Zhu Centre* is a non-profit joint venture located at the Institute of Atmospheric Physics under the Chinese Academy of Sciences (IAP/CAS) in Beijing, China.

NZC has five founders: IAP/CAS; the Nansen Environmental and Remote Sensing Center (NERSC), Norway; the University of Bergen, Norway; the Bjerknes Centre for Climate Research (BCCR), Norway; and the Peking University, China.

Opening of the *NZC*

Representatives from the Chinese and Norwegian authorities formally opened the *Nansen-Zhu Centre* on 4 November 2003. The center is based on an *Agreement of Understanding* between IAP/CAS, NERSC and UoB of 7 August 2001, and a *Memorandum of understanding* between IAP/CAS, NERSC, UoB and PKU of 5 November 2002.

Background

NCZ is established based on the desire to establish and run an attractive and focussed cutting edge climate research network bridging scientists from China, Norway and abroad.

Particularly, *NZC* aims to

- Exchange scientists and graduate students between the founding partners
- Initiate and develop joint research projects between the founding partners
- Co-ordinate and facilitate joint research proposals to be submitted to national and international funding bodies
- Stimulate and support joint publications in international peer-reviewed journals
- Develop co-operation in education and research programs

Research activities

NZC's strategy is to integrate field observations and remote sensing products with numerical modelling and theory to develop cutting-edge knowledge within four prioritised topics:

- Construction of past climate and climate variability based on low-and-high latitude paleoenvironmental reconstructions from tree rings, marine and lake sediments, and by use of modelling (time periods covering last 2,000 years and last 21,000 years).
- Development and evaluation of seasonal, inter-annual and decadal time scale climate predictability systems, and identification of low-and-high latitude teleconnection patterns and mechanisms.
- Model and assess long-term climate effects of regional to global scale atmospheric events like dust storms and pollution emissions.
- Assess sources and sinks of carbon dioxide on seasonal to interdecadal time scales based on integrated use of observations and modelling.

Staff

At the end of 2004, *NZC* employed a total staff of 32 persons, of which five are full-time researchers and 24 receive full-time Master, PhD or Post doc stipends. In addition, there are seven affiliated members.

The staff consists of five full-time research scientists, one part-time research scientist, 7 affiliated research scientists, two administration staff, one Post doc, 15 PhD students and seven master students. The total number of 23 Master and PhD students includes five so-called jointly-educated students.

Production

During 2004, the *NZC* staff published 35 papers in international referee journals. Of these papers, 17 were published in Scientific Citation Index (SCI) journals, 9 in SCI-Extended journals, and 9 in other journals.

For comparison, the number of papers published in 2003 is 12, all of which were published in SCI journals.

Founding partners

- Institute of Atmospheric Physics/Chinese Academy of Sciences (IAP/CAS), China
- Nansen Environmental and Remote Sensing Center (NERSC), Norway
- University of Bergen (UoB), Norway
- Peking University (PKU), China
- Bjerknes Centre for Climate Research (BCCR), Norway

Leader team

- Director Professor Huijun Wang, IAP/CAS
- Co-Director Professor Helge Drange, NERSC/BCCR/UOB
- Deputy Director Professor Zifa Wang, IAP/CAS
- Co-Deputy Director Dr. Yongqi Gao, NERSC/BCCR

The board

- Professor Ola M. Johannessen, Director NERSC, Co-chairman *NZC*
- Professor Huijun Wang, Director IAP/CAS, Co-chairman *NZC*
- Mr. Kåre Rommetveit, Director General, UoB
- Professor Benkui Tan, Dep. Director PKU
- Professor Eystein Jansen, Director BCCR
- Professor Helge Drange, Co-director *NZC*

Scientific advisory board

- Founding partners
- Professor Dengyi Gao, IAP/CAS
- Professor Lennart Bengtsson, Max-Plank-Institute for Meteorology, Germany

http://nzc.iap.ac.cn

Doctoral dissertations

Three PhD-students defended their theses at IAP/CAS in 2004:

- Dabang Jiang - *Last Glacial Maximum climate simulation and East Asian climate change*
- Lixia Ju - *Simulation of the Last Glacial Maximum climate over East Asia with a regional climate model nested in an atmospheric general circulation model*
- Xianmei Lang - *Theory and methodology of short-term climate prediction and study on ensemble prediction experiment*

In addition,

- *Odd Helge Otterå – A model study of the glacial circulation and biogeochemistry with focus on the high northern seas*

defended his PhD at NERSC/UoB in 2003 based on direct collaboration with scientists at *NZC*.

Awards

Two awards have been received in 2004, both by Dabang Jiang:

- Dabang Jiang, Fifty Excellent PhD Thesis Award by Chinese Academy of Sciences
- Dabang Jiang: Xue Du Feng Zheng Award. By IAP/CAS
- Dabang Jiang, *Prize of the President*, by Chinese Academy of Sciences

International meetings

In 2004, *NZC* successfully hosted two international meetings and one summer school:

- 2-3 April*: The second international Dust Model Inter-comparison Project (DMIP) meeting* (20 participants)*;*
- 20-24 September: *The first NZC summer school* (10 participants from Norway, about 40 from China)
- 27-30 October: *The European Climate Forum* (as one of the main hosts) (57 participants)

International visits

NZC has close collaboration with NERSC and has frequent project-dependent exchange of students and scientists with NERSC. The following visits took place in 2004:

- *Chinese visitors to Norway*
  Daoyi Gong, 2 July-31 Aug
  Jiang Zhu, 18-24 Oct
  Jingzhi Su, 3 June- 6 Sep
  Liying Wan, 21 Sep-20 Dec
- *Norwegian visitors to China*
  Anne Britt Sandø, 18-26 Sep
  Ben Marzeion, 18-26 Sep
  Børge Kvingedal, 18-26 Sep
  Dorotea Iovino, 18-26 Sep
  Helge Drange, 22 Feb-6 Mar and 18-26 Sep
  Ingo Bethke, 18-26 Sep
  Johnny A. Johannessen, 23-31 Oct
  Magne A. Drage, 18-26 Sep
  Ola M. Johannessen, 26-31 Oct
  Shujie Ma, 18-26 Sep
  Steinar Orre, 18-26 Sep
  Yongjia Song, 18-26 Sep
  Yongqi Gao, 22 Feb-6 Mar

NZC has also frequent scientific exchanges of students and scientists with Japanese institutes.

Joint international projects

Two joint projects were approved in 2004:

- EU FP6 project *DYNAMITE (Understanding the dynamics of the coupled climate system)*, duration 3 years
- ESA-MOST project *DRAGON*, duration 3 years

Economical budget

NZC received 3.000.000 RMB in 2004, partly from the Chinese and Norwegian partners, and partly from national and international funding agencies.

Prospect for 2005

The Board expect an expansion of the number of staff and the research activities in 2005. This increase is partly due to the set-up of one new research group, and to successful research grants and funding possibilities from the European Commission (EC), the National Sciences Foundation of China (NSFC), the Research Council of Norway (RCN), the Ministry of Science and Technology (MOST), the European Space Agency (ESA), and the Chinese Academy of Sciences (CAS).

Beijing, 18 April 2005,

Ola M. Johannessen (Co-chairman)

Huijun Wang (Co-chairman)

Kåre Rommetveit

Benkui Tan

Eystein Jansen

Staff members

The *NZC* staff members at the end of 2004, split into the different employee categories, are:

Full-time (7 persons)
Huijun Wang (Dir.)
Zifa Wang (Dep. dir.)
Dabang Jiang
Huili Huang
Lixia Ju
Pengyu Sun
Xiquan Wang

Part-time (1)
Xianmei Lang

Associated (7)
Helge Drange (Co-dir.)
Yongqi Gao (Co-dep. dir.)
Haijun Yang
Jiang Zhu
Odd Helge Otterå
Mats Bentsen
Tianjun Zhou

Post doc (1)
Meixue Yang

PhD students (14)
Botao Zhou
Changzheng Liu
Chengming Pang
Chunxiang Shi
Fuying Xie
Jianqi Sun
Jie Li
Gan Luo
Jingzhi Su
Jinping Han
Ke Fan
Lei Yu
Lijuan Chen
Weiwei Fu

Jointly educated PhD student (1)
Xiujuan Zhao

Master students (4)
Mingfeng Su
Xu Yue
Yali Zhu
Yingjie Cui

Jointly educated master students (4)
Hui Zhou.Xiaofeng Ye
Youjiang He
Wenshuai Xu

From the NZC Summer School in Beijing, 20-24 September 2004.

Scientific highlights

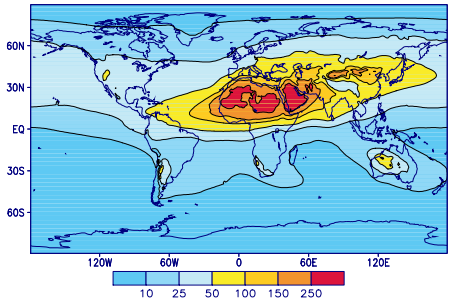
Development of the Global Environmental Atmospheric Transport Model (GEATM)

Aerosol plays an important role in the global climate system through scattering of solar radiation, influence on the formation of clouds, and by providing surfaces for heterogeneous reactions. Since the 1990s, a number of global models have been used to study the characteristics of sulphate aerosol, but only a few models consider the interaction of sulphate and soil aerosols.

At *NZC*, a global environmental atmospheric transport model (GEATM) has been developed to investigate the global distribution, transport and dispersion patterns, and deposition of sulphate, black carbon and dust aerosol. The model adequately considers a series of complex processes like emission, transport and mixing, potential heterogeneous reactions taking place on the aerosol surface, and dry and wet deposition. The emission data is divided into two parts: The quasi-static sources of SOx, NOx and black carbon; and the real-time sources of dust.

Atmospheric forcing fields provided by NCEP/NCAR, ECMWF or General Circulation Models (GCMs) can be used to drive GEATM. The new model adopts a mass-conserving vertical co-ordinate system, it has a horizontal resolution of 1°×1°, and it includes a revised tracer tagged method and improved process analysis. The global emissions of SOx, NOx and black carbon are based on available observations. In addition, an advanced dust deflation module developed at *NZC* is used to determine the dust emissions.

GEATM has been evaluated against global distributed aerosol observations in 2004. The comparison demonstrates that the model appropriately simulates most of the observed features of the seasonal cycle of global dust, sulphate and black carbon. The model will in the future be used to make detailed assessments of the distribution and climate effect of sulphate and soil aerosols.



Simulated global annual mean column of aerosol (mg m^{-2}), including sulphate, BC, and three modes of mineral dust, in 2004 (Luo, G., and Z. F. Wang (2004), Chi. J. Atm. Sci.*, submitted).*

Last Glacial Maximum in China: Sensitivities of climate to paleovegetation and Tibetan ice sheet

The atmospheric general circulation model of the Institute of Atmospheric Physics (IAP-AGCM) simulates colder and drier conditions at the Last Glacial Maximum (LGM, 21.000 yr before present) compared to present day conditions. Specifically, the global annual-average surface temperature and the terrestrial precipitation are reduced by 5.3 °C and 29 %, respectively. It is further demonstrated that the LGM simulation with IAP-AGCM compares favourably to other AGCMs. The model shows, however, a too weak terrestrial cooling when compared to paleoclimatic reconstructions in the tropics.

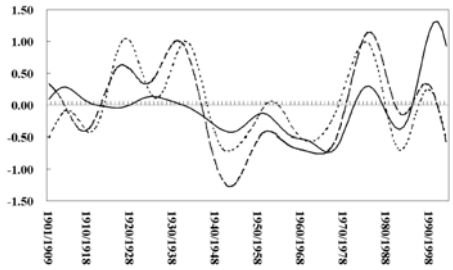
To examine the regional climate response to changes in vegetation and the associated soil characteristics over China, a vegetation reconstruction for China representative for LGM is introduced to the model. The additional cooling due to this change reduces, to some degree, the data-model discrepancies in the tropics. In addition, the presence of continental ice in parts of the Tibetan Plateau is examined. It follows that the glacial-age environment over the Tibetan Plateau is a very important factor for the LGM climate simulation in East Asia.

Figure in here

*Fig-text… (Jiang, D. B., H. J. Wang, H. Drange, and X. Lang (2003): J. Geophys. Res.,**108**, 4102, doi: 10.1029/2002JD002167).*

The Relationship between the Arctic Oscillation and the Pacific Decadal Oscillation

In this study, possible relationships between the Pacific Decadal Oscillation (PDO) and the Arctic Oscillation (AO) in the extended winter (November-March) are investigated. The results indicate that PDO and AO have clear periodicity on both inter-annual and decadal timescales, and that they are positively (negatively) correlated on decadal (inter-annual) timescales. The simultaneous correlation between PDO and AO is dominant on inter-annual timescales, whereas a lag correlation is very strong on decadal timescales with AO leading PDO by 7 to 8 years. The leading decadal variation of AO provides a potential precursory signal for predicting the variation of PDO. Regression analysis and lag correlation reveal a possible mechanism for the AO-PDO coupling on decadal timescales: A strong AO leads lead to a deepened Aleutian Low that is linked to PDO by ocean-atmosphere interaction, and vice versa.

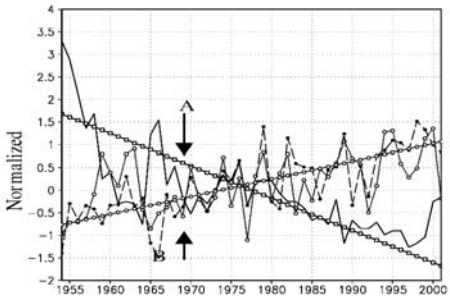


Time series of the standardized AO (1901-1994) (solid line), PDO (1909-2002) (long dashed line), and the inverted Aleutian Low index (1909-2002) (short dashed line) in winter (Sun, J. Q., and H. J. Wang (2004), Chin. Sci. Bull., submitted).

Antarctic Oscillation and the dust weather frequency in North China

A major component of the seasonal to inter-annual Southern Hemisphere (SH) variability is the high-latitude Antarctic Osclillation (AAO) Mode, representing a zonally symmetric exchange of mass between mid and high southern latitudes. Several studies show that AAO is present from surface to the stratosphere, and that it influences SH mid to high latitude surface temperature and precipitation fields. In this study, the focus is on the disastrous dust storm weather phenomena frequently occurring in spring (March-April-May) in North China, and on a possible connection between AAO and the dust storms.

An index denoting the number of days in a year of dust weather events (DWF) like dust haze, blowing dust and dust storm is introduced. It is found that the inter-annual variation of AAO plays a significant role in the dust-related atmospheric circulation during boreal spring. AAO and DWF correlate well, with positive AAO tending to decrease DWF in North China. Two possible mechanisms for the AAO-DWF coupling are identified, one is related to a meridional teleconnection pattern; the other is related to a regional circulation pattern over the Pacific Ocean.



Time series of normalized DWF at Beijing station (solid line), AAO-DJF (dashed line), AAO-MAM (dotted line), and the linear trend of DWF (A) and AAO-MAM

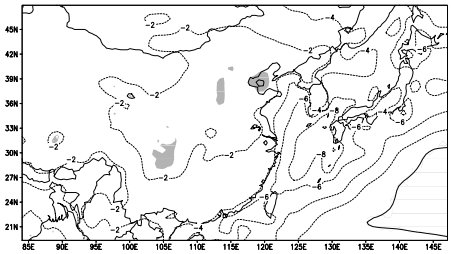
*(B) (Fan, K., and H. J. Wang (2004), Geophys. Res. Lett., **31**, L10201,doi:10.1029/2004Gl019465).*

Simulation of the Last Glacial Maximum climate over East Asia with a regional climate model nested in a general circulation model

The East Asian climate at the Last Glacial Maximum (LGM) has been simulated using a regional climate model (RegCM2) nested to a global atmospheric general circulation model (IAP-AGCM). The boundary conditions for LGM follow the protocol from the Paleoclimate Modeling Intercomparison Project (PMIP) with lower sea surface temperature (SST), extended extent of ice-sheets and sea ice, lower sea level, lower concentration of atmospheric CO_2, and slightly different Earth orbital parameters compared with present day (PD) conditions. 6006

The nested regional model gives a simulated annual mean surface air temperature 2-4 ºC below PD values over the East Asian continent. The coldest temperature of about 8 ºC is found in the vicinity of PD coastal areas due to changes in the land-sea distribution. The obtained changes in precipitation are complex, with drier conditions during LGM over eastern China and the surrounding regions, and wetter conditions over western China.

It is also found that the climate in RegCM2 is in better agreement with geological reconstructions in the East Asian region compared to the global model. This is caused by more detailed topography and more complex physics in the regional model. The study therefore strongly suggests that local boundary conditions and local forcing are important for an accurate simulation of LGM in East Asia.



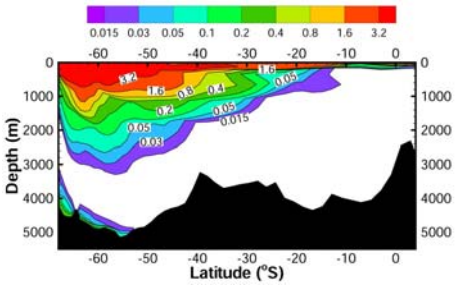
Annual average surface air temperature from RegCM2 (°C) for LGM minus PD. Areas with significance level below 95% are shaded (Ju, L. X., H. J. Wang, and D. B. Jiang (2004), J. Geophys Res., submitted).NEW FIGURE!

Ocean tracer and carbon cycle modelling

Atmospheric carbon dioxide (CO_2) traps heat that otherwise would radiate into space, and is thus categorised as a greenhouse gas. Instrumental observations show that the global temperature increased by about 0.5 °C during the 20th century. Based on a thorough analyses of the present knowledge, the United Nation's 2001 *Intergovernmental Panel on Cliamte Change* (IPCC) report concluded that a large part of the warming was probably due to increasing concentrations of the atmospheric greenhouse gases like CO_2.

The World Oceans play an important role in regulating the atmospheric concentration of CO_2 through the huge chemical capacity of the ocean to absorb and store the gas. In fact, the oceanic reservoir of CO_2 is about 50 times of that of the atmosphere. Ocean General Circulation Models (OGCM) with modules for the ocean carbon cycle are the primary tools to investigate the ocean uptake of CO_2 both for the present-day climate state, and for a climate state with higher concentrations of CO_2 and higher temperatures.

In this activity, observed distributions of Chlorofluocarbons (CFCs) and radioactive nuclides from atmospheric fallout and nuclear reprocessing plants have been used to evaluate the rate and distribution of the ocean uptake of atmospheric trace gasses. The exercise is particularly powerful to tune the poorly unknown small-scale vertical and horizontal mixing parameterisations in OGCMs. The improved model system will in the future be used to study the impact of sand storm deposition on the ocean carbon cycle in the northwest Pacific Ocean.



*Simulated vertical distribution of CFC-11 (pmol kg^{-1}) at 88 °W in the Southern Ocean in 1993 (Gao, Y. and H. Drange, Adv. Atm. Phy., **21**, 755-66, 2004).*

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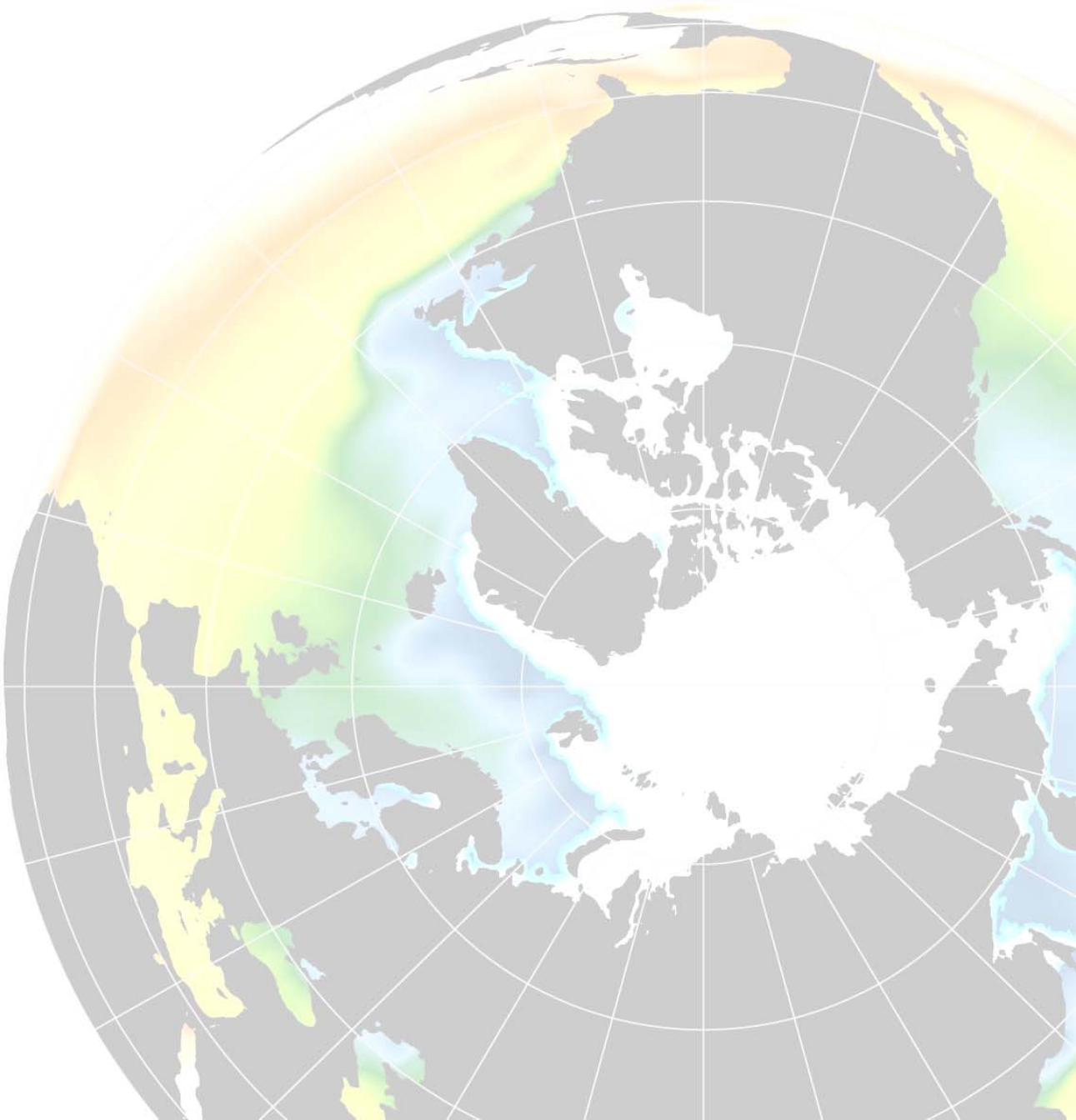

From the formal opening of the Nansen-Zhu International Research Centre, Beijing, 4 November, 2003

Left: Mr. Børge Brende, Minister of the Norwegian Ministry of the Environment

Under: From left: Mrs. Bente Johannessen (NERSC), Mr. Mingyi Ge (CAS), Dr. Yongqi Gao (NERSC, Co-Dep. Dir. *NZC*), Dr. Beatriz Balino (BCCR), Prof. Ola M. Johannessen (NERSC, Co-Chairman Sci. Adv. Board *NZC*), Prof. Huijun Wang (IAP/CAS, Dir. *NZC*), Mr. Børge Brende (Norwegian Minister of the Environment), Mr. Tor Chr. Hildan (Ambassador, Royal Norw. Embassy, Beijing), Prof. Helge Drange (NERSC, Co-Dir. *NZC*), Prof. Bojie Fu (CAS), Prof. Rune Nilsen (Vice Rector UoB), Prof. Zewei Lu (NSFC), Mr. Gang Li (MOST), Dr. Jurgen Sanders (European Commission), Prof. Benkui Tan (PKU), (oversetter CAS), Prof. Zhongxiang Hong (IAP/CAS), Assoc. Prof. Xiquan Wang (*NZC*), and Prof. Sixiong Zhao (IAP/CAS).

The Nansen-Zhu International Research Center, Beijing, China

http://*nzc*.iap.ac.cn

Director: Prof. Huijun Wang (IAP/CAS, NZC)
Co-Director: Prof. Helge Drange (NERSC, NZC, BCCR, UoB)

Founding partners:

Institute of Atmospheric Physics/Chinese Academy of Sciences (IAP/CAS), Beijing, China
Nansen Environmental and Remote Sensing Center (NERSC), Bergen, Norway
Bjerknes Centre for Climate Research (BCCR), Bergen, Norway
University of Bergen (UoB), Bergen, Norway
Peking University (PKU), Beijing, China