10 Year of Collaboration (2004-2013)

Nansen-Zhu International Research Centre
Institute of Atmospheric Physics
Chinese Academy of Sciences
Beijing, China

Report from the Advisory Board

10 Year of Collaboration

The board is pleased to see the achievement Nansen-Zhu International Research Centre *(NZC)* has made over the past 10 years in terms of scientific production, research training activities, mobility, and joint scientific publications with authors from both Norway and China. There is no doubt that the *NZC* has been instrumental for Chinese-Norwegian collaboration in climate research and that the centre has moved the scientific frontline forward. The board also congratulates to Prof. Huijun Wang, director-general of the Institute of Atmospheric Physics (*IAP*) of Chinese Academy of Sciences (*CAS*) and director of *NZC,* being appointed as an Academician of *CAS.*

Vision

The overarching goal of the *NZC* is to be an internationally acknowledged climate research and training centre with emphasis on tropical and high-latitude regions, and the teleconnections between these regions, for past, present and future climate.

Organization

The *NZC* is a non-profit joint venture located at the *IAP/CAS* in Beijing, China.

Aims

- 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

Staff

At the end of 2013, *NZC* has a staff of 60 persons. The staffs consist of 17 full-time members with 16 research scientists and 1 administration, 2 joint member, 24 PhD students and 17 master students in addition to 17 collaborating scientists.

Founding Partners

- Institute of Atmospheric Physics, Chinese Academy of Sciences (*IAP/CAS*), Beijing, China
- Nansen Environmental and Remote Sensing Center (*NERSC*), Bergen, Norway
- University of Bergen (*UoB*), Bergen, Norway
- Peking University (*PKU*), Beijing, China
- Uni Research (*UniRes*), Bergen, Norway
- Nanjing University (*NJU*), Nanjing, China

Leader Team

- Director Professor Huijun Wang, *IAP/CAS*
- Deputy Director Professor Yongqi Gao, *NERSC/IAP*
- Deputy Director Professor Jianqi Sun, *IAP/CAS*
- Research school leader, Professor Tore Furevik, *UoB*

The Advisory Board

- Professor Ola M. Johannessen, Nansen Fellow *NERSC*, Co-chairman
- Professor Huijun Wang, Director *IAP/CAS*, Co-chairman
- Professor Nils Gunnar Kvamstø, Director Geophisical Institute/*UoB*
- Professor Benkui Tan, Dep. Director, *PKU*
- Professor Eystein Jansen, *UniRes*
- Professor Xiuqun Yang, Director of School of Atmospheric Sciences, *NJU*

http://nzc.iap.ac.cn

Cover Photo:

Nansen-Zhu International Symposium, October 22-24, 2013 in Beijing

PUBLICATIONS

Over the past 10 years, *NZC* staff has published 443 papers in international referee journals. Of these papers, 309 were published in Scientific Citation Index (SCI) journals, 134 in other journals. In 2013, 39 papers were published in SCI journals and 24 papers in other journals.

DOCTORAL DISSERTATIONS

Forty-four PhD-students defended their theses at *IAP/CAS* over the past 10 years with five of them defended in 2013:

- Donglin Guo: Frozen ground on the Tibetan Plateau: impact on land surface water and heat exchange and response to climate warming (2012.11.02) supervised by Prof. Huijun Wang
- Qing Yan: Projections of the Greenland ice sheet mass balance in the 21st century (2013.04.25) supervised by Profs. Ola M. Johannessen and Huijun Wang
- Huanlian Li: Interannual variability of Northeast China winter climate and inter-decadal shift of the western African summer monsoon (2013.05.17) supervised by Prof. Huijun Wang
- Shan Liu: A short-term climate prediction system based on a coupled Climate System Model (2013.05.21) supervised by Prof. Huijun Wang
- Jiehua Ma: Dynamic downscaling of seasonal climate prediction research and climate projection in the 'Blue Arctic' conditions (2013.05.21) supervised by Prof. Huijun Wang

In addition, fifteen Master-students have defended their thesis at IAP/CAS over the past 10 years with two of them defended in 2013:

- Leqiong Han: Improving short-term prediction of summer rainfall in North China by decomposing inter-annual and decadal variability (2013.06.05) supervised by Prof. Ke Fan
- Dong Chen: Change in meridional circulation and its relation to summer typhoon activities (2013.06.05) supervised by Prof. Huijun Wang

AWARDS

NZC staff has received 40 awards at Ministry, National and International levels over the past 10 years. Six of them were in 2013:

- Prof. Ke Fan: Winner of Outstanding Young Scientist by National Natural Science Foundation of China
- Fei Li, Shengping He: Excellent Student, University of Chinese Academy of Sciences
- Ya Gao, Bo Sun: Merit Student, University of Chinese Academy of Sciences, 2012-2013.
- Qing Yan: Outstanding Graduate in University of Chinese Academy of Sciences, 2013

STAFF MEMBERS

By the end of 2013, the different staff categories are:

FULL-TIME (17)

Huijun Wang (Dir., Prof. and Academician)
Jianqi Sun (Dep. Dir., Prof.)
Shuanglin Li (Prof.)
Dabang Jiang (Prof.)
Ke Fan (Prof.)
Aihui Wang (Prof.)
Lixia Ju
Yali Zhu
Ying Zhang
Lei Yu
Jun Wang
Huopo Chen
Tao Wang
Entao Yu
Qing Yan
Donglin Guo
Yanan Wang (Admin.)

JOINTLY (2)

Yongqi Gao (Dep. Dir., Prof.)
Ola M. Johannessen, Visiting Professor

COLLABORATORS (17)

Benkui Tan; Botao Zhou; Eystein Jansen; Helge Drange; Hui Gao; Ingo Bethke; Jianjian Fu; Jinping Han; Jingzhi Su; Mats Bentsen; Odd Helge Otterå; Tore Furevik; Weiwei Fu; Xianmei Lang; Xiuqun Yang; Xu Yue; Zhongshi Zhang

PHD STUDENTS (24)

Bo Sun, Dong Chen; Feifei Luo; Ke Liu; Baoqian Tian; Fei Li; Hui Liu; Jiang Jiang; Jianghua Wan; Juan Ao; Kaiqing Yang; Mengzi Zhou; Na Liu; Sha Wu; Shengping He; Wei Hua; Xiangyu Li; Xuedong Cui; Ya Gao; Yanyan Huang; Yue Sui; Zhiguo Yin; Zhiping Tian; Zhiqing Xu

MASTER STUDENTS (17)

Baohuang Su; Chen Li; Dongxia Yang; Jie Sun; Jihang Li; Jing Li; Jing Ming; Longgang Wu; Mengqi Zhang; Qin Hu; Tingting Han; Xiaomin Zhou; Xin Hao; Ye Feng; Yeyi Liu; Yuanyuan Jing; Zhiming Xie

BILATERAL VISITS

NZC has close collaboration and frequent project-dependent exchange with students and researchers among the Norwegian partners. Over the past 10 years, there were 80 person/time visits from China and 129 person/time visits from Norway.

In addition, Yongqi Gao (*NERSC/NZC*) annually travelled 4-5 times back and forth between Beijing and Bergen over the past 10 years under this joint appointment.

ANNUAL MEETINGS

NZC has annual meetings with all staff and participants from Norwegian and Chinese partners. For 10 year celebration, *NZC* organized an international symposium on 'Monsoon variability and teleconnections' during October 22-24, 2013 in Beijing with more than 100 participants from Norway, Russia, UK and China. A special issue in *Atmospheric and Oceanic Science Letters* (co-editors: Wang, H.J. and Johannessen, O.M.) was published with 30 papers contributed by the Chinese and Norwegian partners.

SUMMER SCHOOLS

NZC has organized or jointly-organized five summer schools over the past 10 years. There were: Summer school in 2004 in Beijing; Summer school in 2006 in Bergen; Summer school in 2008 in Beijing; Summer school in 2010 in Innsbruck; Summer school in 2012 in Beijing

ECONOMY

NZC receives funding partly from the Chinese and Norwegian partners and partly from national and international funding agencies. *NZC* received 7050 kRMB (840 kEURO) in 2013.

PROSPECTS FOR 2014

The Board expects an expansion in research activities in 2014. This is partly due to more funding possibilities from the National Natural Science Foundation of China (*NSFC*), the Research Council of Norway (*RCN*), the Ministry of Science and Technology (*MOST*), and the *CAS* and partly due to the stable support from Norwegian partners and student exchange with Nansen Scientific Society.

RESEARCH SUMMARY

JOINT RESEARCH

Prof. Yongqi Gao, Prof. Tore Furevik

Over the past 10 years, climate teleconnections between high and low latitudes and between the different ocean basins have been the key research area for the joint research as well as research training at the *NZC*. Supported by various projects coordinated by *NZC* or by the partners in Bergen (e.g. Research Council of Norway supported projects DecCen: Exploring the decadal to century timescale climate variability in East Asia over last millennium; BlueArc: Impact of 'Blue Arctic' on climate at high latitudes, Research school in climate), a number of scientific papers with authors from both Norway and China have been published. It was suggested that the strong tropical volcano eruption could modulate the Pacific Decadal Oscillation (Wang et al., 2012); the anthropogenic forcing were important for the decadal shift of precipitation over eastern China in late 1970s (Wang et al., 2013); the change in spring Arctic sea-ice cover can impact the East Asia summer precipitation via the change in the sea surface temperature in the North Pacific (Guo et al., 2013); the statistic correlation between the winter North Atlantic Oscillation (NAO) and the Indian summer monsoon precipitation (ISM) over the past 600 years was caused by the change in the external forcing which forced both the NAO and ISM, leading to the statistic correlation (Cui et al., 2013); the Pacific Decadal Oscillation (PDO) can modulate the summer precipitation over East China (Yu et al., 2013). There were also joint researches on the Greenland Ice Sheet and global sea level (Yan et al., 2013); Cyclones in China and tropical cyclones over the western North Pacific (Chen et al, 2013; Zhang et al., 2010); ocean tracer studies (He et al., 2012) and paleo-climate (Zhang et al., 2013)

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Wang, T., O.H. Otterå, Y.Q. Gao and H.J. Wang (2012), The response of the North Pacific Decadal Variability to strong tropical volcanic eruptions. Climate Dynamics, DOI: 10.1007/s00382-012-1373-5

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Guo, D., Gao, Y.Q., Bethke, I., Gong, D.Y., Johannessen, O.M., Wang, H.J. (2013), Mechanism on how the spring Arctic sea ice impacts the East Asian summer monsoon. Theoretical and Applied Climatology, DOI: 10.1007/s00704-013-0872-6

Cui, X.D., Gao, Y.Q., Sun,J.Q., Guo, D., Li, S.L., Johannessen, O.M. (2013), Role of external forcing factors in modulating the Indian summer monsoon rainfall, the Arctic Oscillation and their relationship on inter-decadal timescale Climate Dynamics, DOI: 10.1007/s00382-014-2053-4

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Su J., H. Wang, H. Yang, H. Drange, Y.Q. Gao and M. Bentsen (2008): Role of the atmospheric and oceanic circulation in the tropical Pacific SST changes. Journal of Climate, Vol.21, 2019-2034, doi:10.1175/2007JCI1692.1

Yu, L., Furevik, T., Otterå, O.H., Gao, Y.Q. (2013): Modulation of the Pacific Decadal Oscillation on the summer precipitation over East China: A comparison of observations to 600-yrs control run of Bergen Climate Model. Climate Dynamics, DOI 10.1007/s00382-014-2141-5 (accepted)

Yan, Q., Zhang, Z.S., Gao, Y.Q., Wang, H. J., Johannessen, O.M. (2013), The modeled present-day Greenland ice sheet sensitivity to climatic forcing and spin-up methods and its influence on future projections. Journal of Geophysical Research, 118, 1–16, doi:10.1002/jgrf.20156

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Chen, L., Tan, B.K., Kvamstø, N.G., Johannessen, O.M. (2013), Wintertime cyclone/anticyclone activity over China and its relation to upper tropospheric jets. Tellus A. (in press)

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Zhang, R., Yan, Q., Zhang, Z.-S., Jiang, D., Otto-Bliesner, B. L., Haywood, A. M., Hill, D. J., Dolan, A. M., Stepanek, C., Lohmann, G., Contoux, C., Bragg, F., Chan, W.-L., Chandler, M. A., Jost, A., Kamae, Y., Abe-Ouchi, A., Ramstein, G., Rosenbloom, N. A., Sohl, L. & Ueda, H. (2013), Mid-Pliocene East Asian monsoon climate simulated in the PlioMIP. Clim. Past 9, 2085-2099, doi:10.5194/cp-9-2085-2013

National Basic Research Program of China

Prof. Dr. Huijun Wang

The national basic research program of China “Variability of the water and energy cycles and their impact on extreme climate over China under the global warming background” was launched in 2009. The project aims to (i) explore the characteristics of the energy and water cycles over different land surface in East Asia, (ii) study the extreme climates over China and their connection with the energy and water cycles, (iii) improve the skills of the short-term climate prediction and (iv) project the extreme climate over China in the 21st century.

The project has led to more than 70 PhD students and 60 Master students receiving their degrees. Funded by this project, more than 400 papers have been published in the peer-reviewed journals. More than 50% of the published papers were in SCI-Indexed journals.

Paleoclimate Modelling

Prof. Dabang Jiang

Over the past decade, we have used climate models of different complexities, ranging from atmospheric models to Earth system models, to simulate past climates mainly at the mid-Holocene (~6 ka BP), last glacial maximum (~21 ka BP), and mid-Pliocene (~3 Ma BP). Focus is also given to the East Asian climate evolution through the Cenozoic, with special emphasis on the effect of the Qinghai-Tibetan Plateau growth.

Several insights have been obtained. For example, at the mid-Holocene, we found a considerable mode–data mismatch in annual and boreal winter temperature over China based on multiple climate models and proxy data (Fig.; Jiang et al., 2012), which cannot be reconciled by ocean and/or vegetation feedbacks (Tian and Jiang, 2013). The East Asian summer monsoon strengthening can be well explained by an enhanced land–sea thermal contrast and in turn sea level pressure gradient as a result of orbital forcing during the mid-Holocene (Wang et al., 2010; Jiang et al., 2013). At the last glacial maximum, climate models can reproduce the direction of climate changes but fail to capture their magnitude over China (Jiang et al., 2011), even if reconstructed surface conditions are involved (Jiang et al., 2003). Over East Asia, the winter monsoon strengthened north (weakened south) of ~30°N, while the summer monsoon consistently weakened due to changes in land–sea thermal contrast and large-scale atmospheric circulations (Jiang and Lang, 2010). Interactive vegetation, soil, and dust have impacts on global climate of that period (Jiang, 2008; Yue et al., 2011). For the East Asian climate evolution, it is demonstrated that all the Paratethys Sea retreat, the Qinghai-Tibetan Plateau uplift, and the South China Sea expansion play important roles in the formation of the monsoon-dominant environmental pattern (Zhang et al., 2007a, b).

These researches have led 5 PhD students receiving their degrees at *NZC/IAP*.

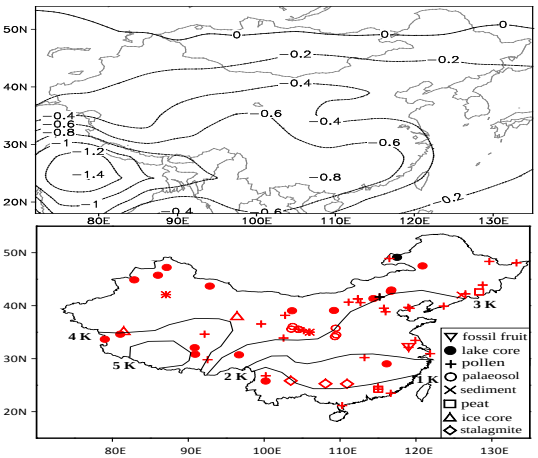

Fig. Upper panel shows mid-Holocene minus baseline differences in annual temperature (units: K) from the ensemble mean of 36 models, and lower panel shows multi-proxy estimates, in which red, black, and blue represent warmer, normal, and colder conditions.

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Zhang, Z. S., H. J. Wang, Z. T. Guo, D. Jiang (2007b), Impacts of tectonic changes on the reorganization of the Cenozoic climate patterns in China, Earth and Planetary Science Letters, 257, 622–634.

EXTREME CLIMATE/WEATHER IN CHINA

Prof. Jianqi Sun

According to the Intergovernmental Panel on Climate Change Assessment Report, warming of the climate system is unequivocal. The warming climate is accompanied by changes in the mean and extreme climate. As compared to the mean climate, extreme climate/weather has a more significant impact on human society, ecosystems, and the environment, and is capable of causing thousands of deaths and heavy economic losses. Given the importance of variations in extreme events, governments and academic communities have begun to pay increased attention to extreme climate/weather events in recent decades. Over the past 10 years, NZC has also studied the extreme climate/events in China. It is found that the heat waves has shown a strong decadal change; the dust storm frequency (DWF) in northern China has generally decreased and is linked to the Antarctic Oscillation (AAO); the tropical cyclone activity over the western North Pacific is linked to various dynamic factors including the winter and spring sea-ice cover; the intense snowfall does not have an uniform distribution in China; the projected extreme precipitation shows a general increase in the frequency and intensity of heavy rainfall at the mid and end of the 21st century and an increase in the proportion of heavy rainfall to annual precipitation (Fig.).

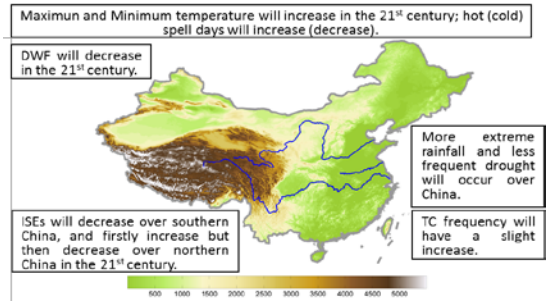

Fig. Long-term projection in dust weather frequency, tropical cyclone, intense snowfall events, flood/drought, and temperature-related extremes before the end of the 21st century. Shading indicates the topography in m.

Selected References:

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Zhang, Y., H. J. Wang, J. Q. Sun, and H. Drange (2010); Changes in the tropical cyclone genesis potential index over the western North Pacific in the SRES A2 scenario. Adv. Atmos. Sci., 27, 1246-1258, doi: 10.1007/s00376-010-9096-1.

OCEAN WARMING AND CLIMATE CHANGE

Prof. Shuanglin Li

Under the context of global climate change, the tropical Indian Ocean is substantially warming during the recent decades. We investigated the impact of the warming on large-scale atmospheric circulation, and found that it may have played a considerable role in inducing the observed trend of NAO/NAM toward its positive polarity, and may have cancelled a fraction of the radiative cooling effect induced by the ozone depletion over the Antarctic (Li et al. 2010). But the warming has not contributed significantly to the observed weakening trend of East Asian summer monsoon since the late-1970s (Li et al. 2008).

The tropical northwestern Pacific plays the crucial role for global climate. It is also one of the source regions for the moisture, energy and dynamical

wave influencing the East Asian summer climate, which is still a challenge to simulate and predict even in the current climate models. We evaluated the ability of twelve AGCMs attending the AMIP II forced with the historical SST and found a divergence in skills among the models. Then, we diagnosed the mechanism and found the model's biases in simulating the ENSO teleconnection are responsible for the divergence in skills (Zhang et al. 2012). We also studied the role of the SST anomalies (SSTA) within the region in modulating the connection of ENSO with the NAO, and found an NAO/NAM response to the SSTA (Li et al. 2006).

A so-called pan-Atlantic SST horseshoe pattern has been found to occur frequently prior to the winter NAO. We studied the influence of its tropical component and found a substantial asymmetry of atmospheric responses with respect to the sign of the SSTA, a NAO vs. a wave train. Furthermore, we explored the mechanism and revealed the importance of the transient eddy feedback for the asymmetry (Li et al. 2007). The AMO is the basin-scale warmth of the North Atlantic on the decadal timescale. We studied its influence on decadal climate variability of Asian climate by observational analyses and modeling, and found that it strengthens both the South Asian summer monsoon and East Asian summer monsoon but weakens the winter monsoon (Li and Bates, 2007; Li et al., 2009; Wang et al., 2009; Luo et al., 2011).

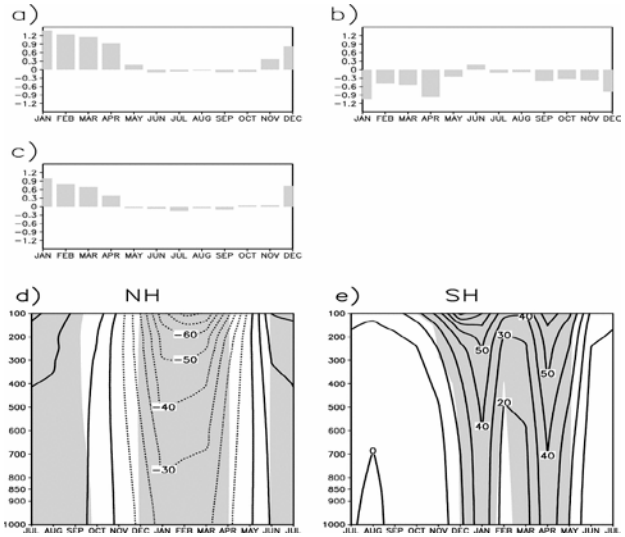

Fig. (a),(b) (c) Seasonal mean trend responses of the NAM, SAM and NAO index, and (e),(f) northern and southern polar cap mean height response in CCM3 to Indian Ocean warming. Shading indicates statistical significance at the 95% level.

Selected References:

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SHORT-TERM CLIMATE PREDICTION

Prof. Ke Fan

Over the past 10 years, to improve the prediction accuracy for East Asian Climate, we have proposed new prediction theories and techniques and we have further established effective short-term climate prediction models for East Asian summer monsoon, rainfall in China, typhoon, hurricane, temperature, etc. These new researches on climate prediction in NZC have been included in the book entitled "advances in climate prediction theory and technique of China" (Wang et al., 2012).

A new scheme is designed to consider both the prediction of summer rainfall pattern in tropical area by the coupled models and observed spatial summer rainfall patterns of historical ''analog years in tropical region.'' When we consider the spatially most similar year and the most dissimilar year in the tropical region, we may give a quite reasonable outlook on the spatial pattern of the precipitation anomaly for the coming year in the East Asian and western Pacific region. The prediction skill for the six coupled models ensemble hindcasts for 1979–2001 was increased to 0.22 by using the new scheme from 0.12 for the original scheme (Wang and Fan, 2009). Another new approach is year-to-year incremental approach, increasing the skill by prediction of inter-annual increment (Fan et al., 2008). The rationale for the year-to-year incremental approach might arise from the existence of tropospheric biennial oscillation (TBO) in the East Asian climate. Thus, a variable in the year-to-year increment might capture TBO features and can amplify prediction signal than a variable in the original form can. This prediction

method has been successfully applied in improved prediction of East Asian summer monsoon (Fan et al., 2012, see Fig.); summer rainfall in China (Fan et al., 2008; Wang and Fan, 2009; Liu and Fan, 2012a), Typhoon (Fan and Wang, 2009) and Atlantic hurricane (Fan, 2010), etc. New scheme can improve prediction ability of each of the models significantly (Fig. 1). Compared with the results of the models, the percentages of improvement in the RMSE of the EASM for the CNRM, UKMO, ECMWF and MME are 54%, 56%, 15%, and 37%, respectively.

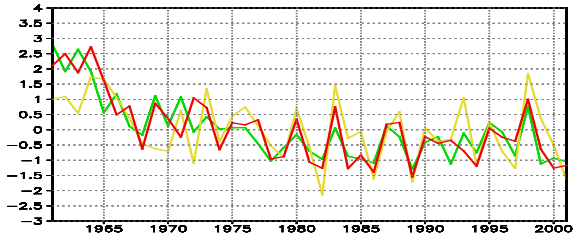

Fig. Verification for new scheme for 1961-2001: observed value (green), the original model (yellow), predicted (red) for MME .

A tier-one global climate prediction system (PCCSM4) has been developed in NZC based on Community Climate System Model Version 4.0 (CCSM4.0) which developed by the National Center for Atmospheric Research (NCAR, US) (Ma and Wang, 2014). As illustrated in Fig. 2, the higher predictability of SST in PCCSM4 can cover the main region of global ocean, especially over the central and eastern Pacific where the influence of ENSO is dominant. PCCSM4 has skillful prediction of atmospheric circulation in tropical and East Asia whereas it has a limited prediction skill for precipitation over East Asia. In addition, statistical downscaling (SD) prediction can improve prediction capability of General Circulation Models (GCMs) for precipitation in China. A year-to-year increment prediction method, Empirical Orthogonal Function, Singular Value Decomposition analyses and the others statistical methods have been applied to develop SD systems for short-term prediction of precipitation over stations in China for four seasons (Lang and Wang, 2010; Liu and Fan, 2012a; 2012b; Chen et al., 2012; Sun et al., 2012; Liu and Fan ,2013), mostly large-scale predictors are derived from GCMs. As illustrated in the figure 3, the original GCM does not reproduce the large precipitation anomaly centered over East China in the scenario of the observations. After downscaling, the distributed pattern of downscaling results is comparable to observations in 1997 and 1998 autumns.

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LAND SURFACE PROCESS

Prof. Aihui Wang

The land surface acts as the lower boundary of the atmosphere and controls fluxes of both energy and water across this boundary. Due to a lack of routine measurements, Land surface models (LSMs) have been widely used to produce consistent global and regional water cycle variables. During the past decade, our efforts have been made to improve the LSMs representation, to investigate the land surface water and energy fluxes changes under the climate change, to reconstruct historical land drought, and to develop high resolution land surface air temperature data sets. Several insightful achievements have been obtained. For example, our new land surface parameterization schemes have improved the model representation in snow processes (Wang and Zeng, 2009); and largely reduced biases in the skin temperature simulations (Zeng et al., 2012; Wang et al., 2014). We also investigated the response the land surface hydrology under the climate change (Wang and Zeng, 2011; Wang and Fu, 2013), and the representative of various reanalysis products over Tibetan Plateau (Wang and Zeng, 2012).

Based on our research over China for the period of 1950-2006, it shows that regions with downward trends were larger than those with upward trends (37% versus 26% of the land area). Trends in drought severity, duration, and frequency suggest that soil moisture droughts have become more severe, prolonged, and frequent during the past 57 yr, especially for northeastern and central China (Wang et al. 2011, Fig.). Land surface air temperature (LSAT) is one of the most important variables in weather and climate studies, and its diurnal cycle is also needed for a variety of applications. Global long-term hourly SAT observational data, however, do not exist. We have developed the first global 0.5 deg hourly SAT data from 1948-2009 by merging in situ CRU data with reanalysis data (Zeng and Wang, 2012; Wang and Zeng, 2013), which facilitates to evaluate of the SAT diurnal cycle of weather and climate models, as well as climate change studies (Wang and Zeng 2014).

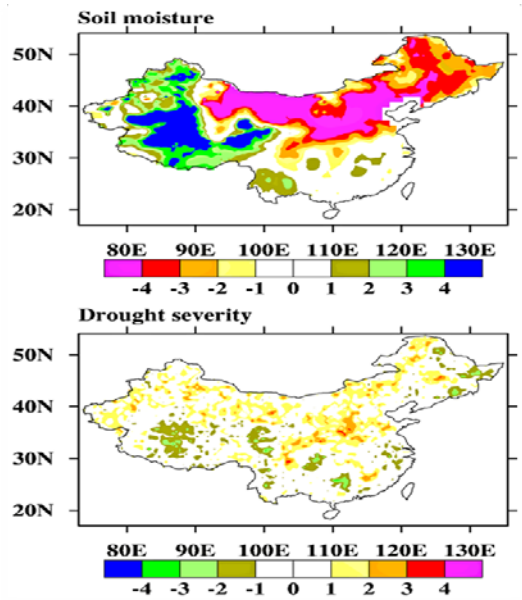

Fig. Annual trends in soil moisture percentile (Top), and drought severity (Bottom) for 1950-2006.The trends were computed using the seasonal Mann-Kendall algorithm. The different colors represent the magnitudes of the statistics.

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Beijing, October 24 2013

Huijun Wang (Co-chairman)
Ola M. Johannessen (Co-chairman)
Nils Gunnar Kvamstø Benkui Tan
Eystein Jansen Xiuqun Yang

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