International Workshop on Interdecadal Variability of the Global Monsoons

10-12 September, 2012

Nanjing, China

Venue: Conference Room at the 1st floor of Meteorology Building, NUIST

会场：南京信息工程大学气象楼一楼报告厅

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世界气候研究计划

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Climate Variability and Predictability

国际气候变率与可预报性研究计划

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Website

http://www.clivar.org/organization/aamp/activities/AAMP_decadal_workshop

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For any further information, please reach us in Room 6510 at Venice Hotel or Room 2002 at NanQi Hotel.

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AGENDA

Time	Location	Events	Remark
Sunday, 9 September, 2012			
10:00－21:00	Venice Hotel & NanQi Hotel	Registration	
18:00	Venice Hotel & NanQi Hotel	Dinner	
Monday, 10 September, 2012			
07:00－07:45	Venice Hotel & NanQi Hotel	Breakfast	
07:45	Gate of Venice Hotel	Shuttle to NUIST	
08:00－08:30	Conference Room	Registration for local Participants	
08:30－08:50	Conference Room	Opening	(1) NUIST (2) AAMP
08:50－09:00	South Gate of Meteorology Building	Group Photo	
09:00－10:30	Conference Room	Invited talks	Session 1
10:30－11:30	North gate of Conference Room	Poster session and morning break	
11:30－12:30	Conference Room	Discussion	Session 1
12:30－14:00	NanQi Hotel	Buffet lunch	
14:00－14:30	Conference Room	Poster introductions	
14:30－15:30	Conference Room	Invited talks	Session 2
15:30－16:30	North gate of Conference Room	Poster session and afternoon break	
16:30－17:30	Conference Room	Discussion	Session 2
17:30－18:00	Conference Room	Invited talk	Session 2
18:00－19:30	NanQi Hotel	Welcome Reception	
19:30	Gate of NanQi Hotel	Shuttle to Venice Hotel	
Tuesday, 11 September, 2012			
07:00－08:15	Venice Hotel & NanQi Hotel	Breakfast	
08:15	Gate of Venice Hotel	Shuttle to NUIST	
09:00－11:00	Conference Room	Invited talks	Session 3
11:00－12:00	Conference Room	Poster session and morning break	

12:00－13:00	Conference Room	Discussion	Session 3
13:00－14:00	NanQi Hotel	Buffet lunch	
14:00－16:00	Conference Room	Invited talks	Session 4
16:00－17:00	North gate of Conference Room	Poster session and afternoon break	
17:00－18:00	Conference Room	Discussion	Session 4
18:00－19:00	NanQi Hotel	Buffet dinner	
19:00	Gate of NanQi Hotel	Shuttle to Venice Hotel	
Wednesday, 12 September, 2012			
07:00－08:15	Venice Hotel & NanQi Hotel	Breakfast	
08:15	Gate of Venice Hotel	Shuttle to NUIST	
09:00－10:30	Conference Room	Invited talks	Session 5
10:30－11:30	North gate of Conference Room	Poster session and morning break	
11:30－12:30	Conference Room	Discussion	Session 5
12:30－13:00	Conference Room	Workshop Summary	
13:00－14:00	NanQi Hotel	Buffet lunch	
14:00	Gate of NanQi Hotel	Shuttle to Venice Hotel	

Venue: Conference Room at the 1st floor of Meteorology Building, NUIST
Poster Display Place: North gate of Conference Room, NUIST

International workshop on interdecadal variability of the global monsoons

NUIST, Nanjing, China, 10-12 September 2012

CLIVAR AAMP (Prof. Bin Wang, Dr Andy Turner et al.) & NUIST (Prof. Jinzhong Min, Dr Weiyu Pan & Dr Gang Zeng)

Notes:

- Early-career international/local scientists to be appointed (before workshop) as rapporteurs for each session (different for each).
- Pairs of invited/attending scientists to be appointed in advance to chair sessions and lead discussions. Discussion points are not exhaustive.
- Posters on display for the whole conference. Poster authors on days 1 and 2 can attend their posters for both session of that day if they wish.

Day 1 (Monday 10 September): Review the present observational evidence of monsoon interdecadal variability

8:30-9:00 Registration / local host and workshop introduction / notify rapporteurs

Session 1: Monsoon decadal variability in the modern observational era[1].

9:00-10:30 (3x30 minute invited talks, including questions; session timekeeper Nicholas Jourdain)

Bin WANG: What drives Decadal variability of the global monsoon?

H ANNAMALAI: Drivers of interdecadal variability of the Asian Summer Monsoon

Zhaobo SUN: Interdecadal Variation Processes of East Asia Summer Monsoon in the 1970's and their relation to the AO

10:30-11:30 (poster session and morning break)

Posters on topics discussing:

- Measures of the global/hemispheric monsoon and its variability
- Observed modulation of the regional monsoons and their teleconnections

11:30-12:30 Discussion: observed decadal variability of the monsoon (panel discussion chaired by Ken Sperber with panelists Bin Wang, H Annamalai and Zhaobo Sun)

- Are there coherent interdecadal variation patterns on the global scale? How are interdecadal variations of the regional monsoons interrelated?

12:30-14:00 Buffet lunch

Session 2: What do palaeo-modelling and observation tell us about monsoon interdecadal variability?

14:00-14:30 Poster introductions

Each poster author to present a single slide introducing their poster for 1-2 minutes

14:30-15:30 Invited talks (2x30 minutes, including questions; session timekeeper Tianjun Zhou)

Ping ZHAO: Comparisons between modern East Asian monsoon variability and those found in cave records

[1] Defined as the 19th-21st centuries.

from a multi-decadal variability associated with the Asian-Pacific Oscillation during the past 1000 years
Dongxiao WANG: Decadal variability of the climate over the South China Sea inferred from measurement and proxy data

15:30-16:30 Poster session and afternoon break

Posters on topics discussing:

- Palaeo-monsoon co-variability at the global and regional level.
- Comparison between palaeo-proxy and observational data of monsoon interdecadal variability.
- Monsoon tipping points in the proxy record or model data.

16:30-17:30 Discussion: what can palaeo-study teach us about the global monsoons? (panel discussion led by Andy Turner with panelists Ping Zhao, Dongxiao Wang, Tianjun Zhou and Akio Kitoh)

- Do we under-utilize palaeo-study in our understanding of the present monsoon variability and future change?
- How can we use evidence of palaeo-monsoon variations on multi-decadal timescales to constrain monsoon processes in present day simulations?
- Why are the communities distinct and how can there be better interaction between the communities?

Sub-session: our current skill at monsoon modelling

17:30-18:00 (invited talk 1x30 minutes, including questions)

Ken SPERBER: quality of monsoon simulation in the CMIP5 and CMIP3 integrations

18:00 Ice-breaker and evening reception with conference dinner

Day 2 (Tuesday 11 September): Connection between interdecadal monsoon variations and other major modes of interdecadal variability (such as PDO, IPO, or AMO) and the effects of climate change

Session 3: Interconnections between the monsoon regions and decadal variability in the context of climate change.

9:00-11:00 Invited talks (4x30 minutes, including questions; session timekeeper Bin Wang)

Nagaraju CHILUKOTI / K ASHOK: Decadal changes in the relationship between the Indian and Australian summer monsoons

Yihui DING: Observed Inter-decadal weakening of the Asian summer monsoon and different response of South and East Asian monsoons during a warming climate scenario

Xiu-Qun YANG: Decadal change in East Asian monsoon climate system: Natural variability versus anthropogenic forcing

Bodo AHRENS: Variability, climate change or drift in the Indian summer monsoon as simulated by the regional climate model COSMO-CLM

11:00-12:00 Poster session and morning break

Posters on topics discussing:

- Co-variability of the regional and global monsoons on decadal timescales.

12:00-13:00 Discussion: Interconnection and co-variability of the monsoons (panel discussion led by Bin Wang with panelists, Yihui Ding, Xiu-Qun Yang and Bodo Ahrens)

- Do we have the right observational systems to make inter-monsoon comparisons?
- Is the level of data sharing appropriate?
- Have we learned enough about the processes involved in decadal variability to be able to put anthropogenic climate change of the monsoons in context?
- How can we use palaeo-climate simulations to guide us as to the range of future change?

13:00-14:00 Buffet lunch

Session 4: Mechanisms for decadal modulation of the monsoon.

14:00-16:00 Invited talks (4x30 minutes, including questions; session timekeeper Andy Turner)

Buwen DONG: Atlantic Ocean influence on the interdecadal Asian Summer Monsoon and its interaction with the El Niño-Southern Oscillation

Jianping LI: Decadal change in annular modes and their linkage with East Asian monsoon

Zhiwei WU: Modulation of the Tibetan Plateau snow cover on the ENSO teleconnections: From the East Asian summer monsoon perspective

Jacob SCHEWE: A critical humidity threshold for monsoon transitions

16:00-17:00 Poster session and afternoon break

Posters on topics discussing:

- Connections between drivers and global & regional monsoons
- Interaction between drivers or their associated modes of monsoon variability and anthropogenic warming

17:00-18:00 Discussion: mechanisms and model representation of interdecadal modes (panel discussion led by Jianping Li with panelists Buwen Dong, Zhiwei Wu and Jacob Schewe)

- Proposals and ideas for coordinated multi-model experiments to test mechanisms of drivers of the monsoons and modulators of monsoon-ENSO teleconnections.
- Do our models represent AMO/IPO well enough that we can learn anything about their relationships with the monsoon?
    - Do we have enough observed data to test our models?
    - Do we know enough about the processes involved in these phenomena?

18:00 Buffet dinner

Day 3 (Wednesday 12 September): Decadal monsoon prediction

Session 5: Using our knowledge of decadal variability to further monsoon prediction. (Session chairs and discussion leaders TBA)

9:00-10:30 Invited talks (3x30 minutes, including questions; session timekeeper Matthieu Lengaigne)

Noel KEENLYSIDE: Near-term climate prediction: new opportunities and challenges

Harry HENDON: Decadal variation of ENSO predictability

Kyung-Ja HA: Interdecadal Change in the Relationship between ENSO and the Intraseasonal Oscillation in East Asia

10:30-11:30 Poster session and morning break

11:30-12:30 Discussion: barriers to better dynamical prediction and the impact of ENSO diversity (panel discussion led by Harry Hendon with panelists Noel Keenlyside, Kyung-Ja Ha and Matthieu Lengaigne)

- What are the barriers to better dynamical prediction of monsoon decadal variability?
- What is the status of dynamical seasonal forecasting in the context of different ENSO flavours and background state conditions?
    - The IOD or Modoki-mode ENSO.
    - Role of the mean state.

12:30-13:00 Synthesis of rapporteurs' comments and meeting wrap-up

- Tentative outcomes
- Actions going forward

13:00 Buffet lunch

LIST OF POSTERS

S3 Hua CHEN: Decadal Global Monsoon in CCSM3

S3 Miao-ni GAO: Decadal change in relationship between spring Arctic Oscillation and East Asian summer monsoon in the late 1990s

S4 Jinhai HE: The effect of interdecadal variation of East Asian monsoon leading mode in the past 30 years on South China precipitation and its possible causes

S1 Deepesh JAIN: Interdecadal variability of the Indian monsoon in an atmospheric general circulation model

S4 Zhihong JIANG: How do coldwaves in China respond to a warming climate?

S1 Nicolas JOURDAIN: Variability of the Tropospheric Biennial Oscillation

S4 Hisayuki KUBOTA: Interdecadal variability of western North Pacific summer monsoon through the Pacific-Japan (PJ) pattern

S5 K Niranjan KUMAR: On the interdecadal variation of intensity if tropical cyclones in the Arabian Sea: role of ocean heat content

S5 Matthieu LENGAIGNE: Influence of Indian Ocean dipole and Pacific recharge on next year's El Nino: interdecadal robustness

S3 Aurel MOISE: Decadal variability of the Australian monsoon and future projections as represented in the CMIP5 models

S3 Yuwei LIU: Evidence of coordinated weakening of the Asian and West African monsoons and links to North Atlantic cooling

S3 Chu-han LU: Interdecadal linkages between Pacific decadal oscillation (PDO) and interhemispheric air mass oscillation (IHO) and their possible connection with the East Asian monsoon

S1 Elinor MARTIN: Multi-decadal variability of West African rainfall in observations and CMIP5 simulations

S2 Yu-jing QIN: The South Asia high reconstruction process from April to May and its relationship with convective activities over the Indo-China peninsula

S2 Zhengguo SHI: Orbital-scale Pacific/East Asia teleconnection and anti-phased variations of summer precipitation

S1 Che SUN: Interdecadal variation of surface winds over China Marginal Seas

S5 Ruifang WANG: Typhoon track changes associated with global warming

S1 Baoqiang XIANG: Decadal Changes of Asian Summer Monsoon Onset

S3 Xiao XIE: Analysis on the upper-air temperature over Eastern China under the background of global warming**S5** Junpeng YUAN: Influence of Indian Ocean dipole mode on North Indian Ocean tropical cyclones

S4 Wen ZHOU: Possible connection between Pacific Oceanic interdecadal pathway and East Asian Winter monsoon

[UNABLE TO ATTEND] **S1** Qun XU: Interdecadal changes and causal analysis of Meiyu periods in the mid-lower Yangtze basin during 127 recent years (1885-2011)

Session poster totals

Session 1: 5 posters

Session 2: 2 posters

Session 3: 6 posters

Session 4: 4 posters

Session 5: 3 posters

Additional non-presenting attendees

Miss Jungeun CHU jechu@pusan.ac.kr

Jun Matsumoto jun@center.tmu.ac.jp

Yu Pei yupei@lasg.iap.ac.cn

And members of the CLIVAR Asian-Australian Monsoon Panel

ABSTRACTS

Poster Session

Recent Change of the Global Monsoon Precipitation (1979-2008)

Bin Wang[1, 2], Jian Liu[3*], Hyung-Jin Kim[4], Peter J. Webster[5], and So-Young Yim[2]

(1. Department of Meteorology, University of Hawaii at Manoa, Honolulu, HI 96825, USA. 2. International Pacific Research Center, University of Hawaii at Manoa, Honolulu, HI 96825, USA. 3. State Key Laboratory of Lake Science and Environment, Nanjing Institute of Geography and Limnology, Chinese Academy of Sciences, Nanjing 210008, China. 4. Research Institute for Global Change, Japan Agency for Marine-Earth Science and Technology, 3173-25 Showa-machi, Kanazawa-ku, Yokohama, Kanagawa 236-0001, Japan. 5. School of Earth and Atmospheric Sciences, Georgia Institute of Technology, Atlanta, GA 30308, USA)

Abstract: The global monsoon (GM) is a defining feature of the annual variation of Earth's climate system. Quantifying and understanding the present-day monsoon precipitation change are crucial for prediction of its future and reflection of its past. Here we show that regional monsoons are coordinated not only by external solar forcing but also by internal feedback processes such as El Niño-Southern Oscillation (ENSO). From one monsoon year (May to the next April) to the next, most continental monsoon regions, separated by vast areas of arid trade winds and deserts, vary in a cohesive manner driven by ENSO. The ENSO has tighter regulation on the northern hemisphere summer monsoon (NHSM) than on the southern hemisphere summer monsoon (SHSM). More notably, the GM precipitation (GMP) has intensified over the past three decades mainly due to the significant upward trend in NHSM. The intensification of the GMP originates primarily from an enhanced east-west thermal contrast in the Pacific Ocean, which is coupled with a rising pressure in the subtropical eastern Pacific and decreasing pressure over the Indo-Pacific warm pool. This is part of a multi-decadal oscillation of the Pacific basinwide SST. While this mechanism tends to amplify both the NHSM and SHSM, the stronger (weaker) warming trend in the NH (SH) creates a hemispheric thermal contrast, which favors intensification of the NHSM but weakens the SHSM. The enhanced Pacific zonal thermal contrast is largely a result of natural variability, whilst the enhanced hemispherical thermal contrast is likely due to anthropogenic forcing. We found that the enhanced global summer monsoon not only amplifies the annual cycle of tropical climate but also promotes directly a "wet-gets-wetter" trend pattern and indirectly a "dry-gets-drier" trend pattern through coupling with deserts and trade winds. The mechanisms recognized in this study suggest a way forward for understanding past and future changes of the GM in terms of its driven mechanisms.

Drivers of interdecadal variability of the Asian Summer Monsoon

H. Annamalai

（IPRC/SOEST, University of Hawaii, USA. E-mail: hanna@hawaii.edu）

Abstract: The seasonal-mean rainfall over the Asian monsoon region varies across all time scales ranging from synoptic to multi-decades. While understanding the processes responsible for synoptic to interannual time scales have received wide attention in the last 3-4 decades, our current knowledge on drivers of multi-decadal variations in monsoon rainfall is rudimentary. Observed rainfall over India and other regions of Asian monsoon domain suggest the presence of multi-decadal variability with epochs (or clustering) of strong and weak monsoon years. At decadal-multi-decadal time scales, CMIP3 and CMIP5 model integrations show no obvious phase relationships between different models or among the ensemble members from the same model. Are these multi-decadal monsoon rainfall variations a mode of natural variability or artifact of data manipulation? Do the decadal-multidecadal variations provide necessary background for variations at interannual time scales? What causes the decadal modulation of extreme rainfall events? Do the well-known longer time scale variations such as AMO, PDO and decadal ENSO have any physical linkage with multi-decadal variations of monsoon rainfall over the Asian monsoon region? These and other related issues will be discussed.

Interdecadal Variation Processes of East Asian Summer Monsoon in 1970's and its Relation to AO

Zhaobo Sun and Weitao Deng

(KLME, Nanjing Institute of Meteorology, NUIST, Nanjing, 210044, P.R. China. E-mail: nimzbs@163.com)

Abstract: The East Asian Summer Monsoon (EASM) is closely related to the severe flood and drought events in the region. The interdecadal variation features and processes of East Asian Summer Monsoon are studied using different data from CMA, Met Office UK and NCEP for 1900-2000.

It is shown that there are two cycles of EASM in last century. The variations of the second cycle of East Asian Summer Monsoon in 1970's are carefully studied. It is pointed that the stronger period of EASM are from 1952 to 1966, the weaker from 1977 to 2000. It seems that the period of 1967-1977 is transition period. The features and processes of EASM in 1970's are investigated. It is shown that the sea level pressure and 500hpa geopotential height anomaly patterns during summer season change sign from 1951-1961 to 1977-2000. The composite SLP and 500hpa height anomalies during the stronger and weaker EASM periods are presented. It is pointed that there are three key significant regions for the interdecadal variations: middle Asia, Europe to north Africa and the Arctic region. The changes start from Atlantic area.

The connections between AO and variability of EASM are investigated. Both winter and summer AO indices have abrupt changed in 1970's . But the position and extensity of summer AO changes much stronger than the winter AO and more strongly coupled to EASM. The correlation coefficient between the summer AO and EASM can be -0.7— -0.8 in the interdecadal variability. It is proposed that the EASM and lower-troposphere circulation anomalies observed in association with the Summer AO may be secondary baroclinic features induced by the land-sea contrasts.

Comparisons between modern East Asian monsoon variability and those found in cave records from a multi-decadal variability associated with the Asian-Pacific Oscillation during the past 1000 years

Ping Zhao

(National Meteorological Information Center, Beijing, China)

Abstract: Modern climate studies show that the Asian-Pacific Oscillation (APO) during boreal summer is a major mode of the earth climate variation linking to the Northern Hemisphere (NH) summer land monsoon. Associated with a positive APO phase are an amplified land–ocean thermal contrast between the Eurasian land and its adjacent oceans, which signifies a stronger than normal NH summer monsoon, with the strengthened southerly or southwesterly monsoon prevailing over East Asia, an enhanced monsoon rainfall over North China, and an reduced monsoon rainfall over the middle-lower valleys of the Yangtze River of China (Zhao et al., 2012).

The Asian-Pacific Oscillation index is reconstructed over the past millennium by the reconstructed air temperature in Beijing and the reconstructed PDO index (Zhou et al., 2009). On the centennial time scale, the East Asian summer monsoon (EASM) indicated by the APO index in the Medieval Warm Period (MWP) was strongest over the past 1000 years, while the EASM in 1450–1570 was weakest over the past 1000 years. Accordingly, the mean value of the flood frequency anomaly was 1.84 floods/10 years over the Yellow River valley during 1000–1200, significantly higher than the value for the LIA, while it was 2.16 floods/10 years over southern China, less than in the Little Ice Age (LIA). This result indicates more precipitation over North China and less precipitation over southern China in the MWP (Zhou et al., 2011), consistent with the results from the modern climate. Thus, compared to the MWP, a longer-time-scale southern flood/northern drought phenomenon occurred in 1400–1600. The climate model results show that corresponding to a larger thermal contrast indicated by APO in the MWP, the monsoon circulation systems and southwesterly winds over East Asia is generally stronger in the MWP than in the current warm period, with more precipitation in North China and less precipitation in southern China (Nan et al., 2012).

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Nan SL, Zhou XJ, Zhao P, Zhou TJ, 2012: A comparison in East Asian summer monsoon between the Medieval Warm Period and the Current warm period. Chinese Sci Bull (submitted).

Decadal Variability of the Climate over the South China Sea inferred from measurement and proxy data

Dongxiao WANG

(South China Sea Institute of Oceanology, CAS)

Abstract: The decadal variation of the Climate over the South China Sea (SCS) is studied using the reanalysis dataset and the coral grayness dataset. Results show that: (1) Luzon Strait Transport (LST) increased but Indonesian Throughflow (ITF) transport decreased after 1975. The strengthening of the easterly wind anomaly east of the Luzon Strait played an important role in the increase of LST after 1975, while the westerly wind anomaly in the equatorial Pacific contributed significantly to the decrease in ITF transport after 1975, accounting for 53% of the change; (2) The trend from the two-century-long annual density of the coral over the northwestern SCS is in a good agreement with that of the global CO2 concentration—a steady decrease from the late 19th century to the late 20th century. This trend reveals the history of the anthropogenic climate change; (3) There is a century-scale abrupt change of coral grayness in SCS at the end of the 1880s that changed from positive anomalies to negative anomalies, which is concomitant with the large-scale distribution of SST anomalies. Meanwhile, there exists negative correlation between the coral grayness in SCS and precipitation in Guangzhou on the interdecadal scale; (4) The cloudiness over the SCS exist a prominent regime shift in the mid-1960s, which can be successfully recorded by coral gray value. The fact that the coral gray value is highly correlated to cloudiness provides a unique perspective on utilizing this coral to study cloudiness variations in the pre-instrumental period. The current study aims at contributing in the effort of identifying specific phenomenon for climate change in the South China Sea on the decadal scale and beyond.

References

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GU Dejun, Dongxiao Wang, Donghuai Sun, Rongzhen Gao and Zhongping Ji, 2006: The coral grayness in northern South China Sea and its description of interdecadal variation of precipitation in south China, Chinese Science Bulletin., 51(2):59-65, doi: 10.1007/s11434-006-9059-1.

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Decadal Changes in the relationship between the Indian and Australian summer monsoons

K. Ashok, C . Nagaraju, A. Sen Gupta and D. S. Pai

(Indian Institute of Tropical Meteorology, Pune, India)

Abstract: In this study, we investigate a long-term modulation in the relationship that exists between Indian summer monsoon rainfall (ISMR) with the subsequent Australian summer monsoon rainfall (ASMR). The two monsoon rainfall time series are significantly correlated at 0.30, at the 95% confidence level. However, the relationship weakens during the 1932-1966 period, with the inter-monsoon correlation for the period falling below statistical significance. We find that this modulation can be largely attributed to the change in the combined influences of ENSO and Indian Ocean Basin Mode (IOBM) sea surface temperature anomalies on the Australian summer monsoon rainfall during the period. Key words: Tropospheric Biennial Oscillation, Indian summer monsoon, Australian summer monsoon ENSO, IOD, ENSO Modoki, IOBM.

Observed Inter-decadal weakening of the Asian summer monsoon and different response of South and East Asian monsoons during a warming climate scenario

Yihui Ding and Ying Sun

（National Climate Center, China Meteorological Administration, Bejing 100081, E-mail: dingyh@cma.gov.cn）

Abstract: Based on the observed analysis by using 123-yr observed data, we have shown the inter-decadal weakening of summer monsoon precipitation in East Asia and China, with two major features identified: (1) the rainfall pattern has undergone an obvious southward shift from North China to South China in the mid –and late 1970s. This shift of the precipitation pattern is in good coincidence with a significant abrupt climate change for other variables ; and (2) occurrence of prolonged droughts in North China and , at the same time, marked flooding in the Yangtze River Valley and South China in the period from the end 1970s to the beginning of the 21st century. The possible causes for the inter-decadal variability of the Asian summer has been further studied .The similar change in the preceding winter and spring snow and SSTA in tropical Pacific ocean are the main drivers through decreasing the land-sea thermal contrast. On the other hand , it has been found that after the end of the 1970s the Indian summer monsoon has also underwent a weakening processes which is in good agreement with that in East Asia. So, the Asian summer monsoon has holistically become weaker during past 30 years. One key issue is how long this unusual change in the Asian summer monsoon and associated precipitation patterns will continue to occur.

By using outputs from climate models of IPCC AR4 we have projected the responses of the South Asian summer monsoon (SASM) and the East Asian summer monsoon (EASM) circulations and precipitation to different warming over land and ocean under a medium warming scenario, SRES A1B. Our results suggest that, at inter-decadal and longer time scales, the change in the SASM circulation is consistent with the change in the TP (Tibetan Plateau) –TIO (tropical Indian Ocean) upper-troposphere thermal contrast (i.e. meridional temperature gradient) that is believed to be the main driver for SASM. Conversely, the change in the EASM circulation is consistent with the change in the TP-TPO (tropical Pacific Ocean) lower-troposphere thermal contrast, which will be enhanced due to the decreasing winter snow over TP and SSTA over the tropical Pacific.

Further analyses suggest that increases in moisture and change in cloud cover induced by global warming may cause different upper-troposphere warming over the TP and the tropical oceans , respectively。Because the warming over the TIO is stronger than that over the TP, the TP-TIO meridional thermal contrasts will decrease in the future, thus leading to continuous weakening of tropical easterly jet and the monsoon intensity measured with W-Y monsoon index. However, in the lower layer of EA, a larger heating effect in the region of the TP than that over tropical Pacific due to decrease in winter snow can increase the zonal land and sea thermal contrast as well as the EASM intensity.

In conclusions, since mid-or late 1970s, the Asian summer monsoon has experienced the inter-decadal weakening. However, in this century the South Asian summer monsoon will continue to weaken (mainly for the monsoon circulation) whereas the East Asian summer monsoon will gradually strengthen, especially after 2040's. It should be pointed out that the projection of the summer monsoon change are subject to a large uncertainty which are also discussed in this report, especially for development of convection over tropical oceans.

Key words: South and East Asian summer monsoons; thermal contrasts; global warming

Decadal change in East Asian monsoon climate system: Natural variability versus anthropogenic forcing

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Abstract: The East Asian monsoon (EAM) has been experiencing a considerable decadal weakening since around the end of 1970s with a significant southward shift of increased precipitation in East Asia. Such a decadal change has caused serious consequences by increasing drought and/or flooding and altering water resource distribution, which can affect the sustainable development in East Asian region. However, the reason for the decadal change in EAM remains unclear. This talk will present our current understandings on this issue. Two fundamental questions will be raised. First, what is the role of the natural variability? In this regard, the Pacific Decadal Oscillation (a striking phenomenon with decadal warming in the tropical Indo-Pacific basin and cooling in the midlatitude North Pacific) and its effect on the EAM change will be described. It is demonstrated that The EAM weakening is closely related to the tropical ocean warming. Yet, its role exhibits considerably basin-dependent. The tropical eastern Pacific warming tends to weaken EAM, while the tropical Indian Ocean warming plays an opposite role. Second, whether the decadal weakening of EAM can be attributed to the increased anthropogenic aerosols over East Asia? In this regard, the effect of increased aerosols on EAM simulated by a state-of-the-art atmospheric general circulation model (GCM) with aerosol-cloud-radiation-precipitation interaction, in comparison with the increased CO2 effect, will be discussed. Most of the IPCC AR4 models show that the increased CO2 tends to enhance the EAM, which can not be used to explain the observed EASM weakening. The state-of-the-art model (CAM5/NCAR) with aerosol direct and indirect effects shows that increased anthropogenic aerosols tend to weaken East Asian summer monsoon with precipitation shifted to southern China and adjacent oceanic regions by reducing land-sea thermal contrast, which is mostly caused by the aerosol's radiative effect. The model also shows that the increased anthropogenic aerosols tend to reduce the precipitation over most of the land areas, especially over Southeast Asian sub-continents , which is mostly related to aerosol's cloud-microphysical (indirect) effect (i.e., the decreased droplet effective radius).

Variability, climate change or drift in the Indian summer monsoon as simulated by the regional climate model COSMO-CLM

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Abstract: Previous transient projections simulations with the regional climate model COSMO-CLM gave mixed results for the Indian summer monsoon season (Dobler and Ahrens 2011). For instance, they showed significantly decreasing trends for the all-India monsoon rainfall in contrast to their driving ECHAM5/MPIOM model. However, it is not yet clear whether this is the result of climate change, natural variability, or model drift. For investigating this, we conducted long (150 years) regional climate model simulations with constant pre-industrial greenhouse gas concentrations. The pre-industrial control run is not disturbed by any external forces and therefore provides an estimate of the internal variability of the climate (model) system. The results show large variability in the simulated monsoon intensity but no model drift, and this paper compares the variability with long-term all-India rainfall variability. This variability will be used to discuss the projected changes in climate. Possible causes behind the changes in the monsoonal precipitation on the basis of regional and global climate model projections will also be addressed.

The Asian Summer Monsoon: An Intercomparison of CMIP5 vs. CMIP3 Simulations of the Late 20th Century

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Abstract: The boreal summer Asian monsoon has been evaluated in 25 Coupled Model Intercomparison Project-5 (CMIP5) and 22 CMIP3 GCM simulations of the late 20th Century. Diagnostics and skill metrics have been calculated to assess the time-mean, climatological annual cycle, interannual variability, and intraseasonal variability. Progress has been made in modeling these aspects of the monsoon, though there is no single model that best represents all of these aspects of the monsoon. The CMIP5 multi model mean (MMM) is more skillful than the CMIP3 MMM for all diagnostics in terms of the skill of simulating pattern correlations with respect to observations. Additionally, for rainfall/convection the MMM outperforms the individual models for the time mean, the interannual variability of the East Asian monsoon, and intraseasonal variability. For the climatological annual cycle, the pattern correlation of the time (pentad) of monsoon peak and withdrawal is better simulated than that of monsoon onset. The onset of the monsoon over India is typically too late in the models. The extension of the monsoon over eastern China, Korea, and Japan is underestimated, while it is overestimated over the subtropical western/central Pacific Ocean. The anti-correlation between anomalies of all-India rainfall and NINO3.4 sea surface temperature is overly strong in CMIP3 and typically too weak in CMIP5. For both the ENSO-monsoon teleconnection and the East Asian zonal wind-rainfall teleconnection, the MMM interannual rainfall anomalies are weak compared to observations. Though simulation of intraseasonal variability remains problematic, several models show improved skill at representing the northward propagation of convection and the development of the tilted band of convection that extends from India to the equatorial west Pacific. The MMM also well represents the space-time evolution of intraseasonal outgoing longwave radiation anomalies.

Keywords： Asian summer monsoon; Climate model; Intercomparison; Model Systematic Error; Skill Metrics

Atlantic Ocean influence on the interdecadal Asian Summer Monsoon and its interaction with the El Niño-Southern Oscillation

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Abstract: Instrumental records of sea surface temperatures (SSTs) in the Atlantic exhibit an oscillation with a period of 65-80 years, which is referred to as the Atlantic Multidecadal Oscillation (AMO). The AMO is thought to be related in part to multidecadal fluctuations of the Atlantic Thermohaline Circulation (THC) that involves a northward movement of warm surface waters balanced by a southward movement of cold deep waters and transports ~1PW heat northwards. A wide range of regional climate signals has been linked to the AMO, including important changes in rainfall in the Sahel and North-East Brazil, in North American, European summer climate, the Asian summer monsoon (ASM). The evidence that the AMO can affect the ASM is of particular importance because of the huge social and economic influence of the ASM. In view of the evidence that the AMO may be predictable on decadal timescales, advances in understanding the impact of the AMO on the ASM could also make an important contribution to the development of skilful decadal predictions of the ASM. In this presentation, the AMO, its influence on the Asian Summer Monsoon, and its modulation on the El Niño-Southern Oscillation (ENSO)-ASM interaction based on both observations and model simulations will be presented. In particular, the physical mechanisms via which that AMO affects ASM and the ENSO-ASM interaction will be elucidated.

Decadal change in annular modes and their linkage with East Asian monsoon

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Abstract: There are two annular belts of action (ABAs) in the extratropical general circulation over middle and high latitudes of each hemisphere, respectively. The Northern Hemisphere annular mode (NAM) or Arctic Oscillation (AO) is just a north-south seesaw structure in air mass between the two ABAs over the Northern Hemisphere. The Southern Hemisphere annular mode (SAM) or Antarctic Oscillation (AAO) is simply a north-south seesaw pattern in air mass between the two ABAs over the Southern Hemisphere. The NAM/AO and SAM/AAO respectively explain 20~30% variance of variability of NH and SH extratropical circulations. The analysis indicates that the anomalous Ferrel cell stands out as a dominant signal in the zonal-mean vertical circulation anomalies related to the annular modes, implying a strong dynamical property of the annular modes. The annular modes are important links between climate variability over high and middle latitudes. The annular modes possess very strong decadal and interannual variability.

Both the SAM and NAM have important influences on variability of the East Asia monsoon system. There is a significant out-of-phase relationship between the East Asian winter monsoon and winter NAM. Through its impact on the Siberian High the NAM exerts influences on the East Asian winter monsoon. Moreover, the strong negative NAM is a major contributing factor to severe East Asian or NH winter snowfall. The decadal change in the spring dust storm frequency in Northwest China is associated with that in the previous winter NAM. On the inter-annual time scale the East Asian summer monsoon and monsoon rainfall are highly correlated with the late spring NAM.

The East Asian winter monsoon is also highly associated with the boreal autumn (SON) SAM anomalies. There is a significant negative correlation between preceding boreal winter (DJF) SAM and spring precipitation over South China. The variability of summer precipitation in the middle and lower Yangtze River valley is significantly positively correlated with the boreal spring (MA) SAM. We proposed a concept of coupled oceanic-atmospheric bridge to explain the mechanism on how the preceding signals of SAM mentioned above impact the East Asian monsoon. The intimate linkage between the SAM and East Asian monsoon can provide a useful way to predict the East Asian monsoon variations.

Modulation of the Tibetan Plateau Snow Cover on the ENSO Teleconnections: From the East AsianSummer Monsoon Perspective

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Abstract: The East Asian summer monsoon (EASM) may exhibit rather large variability between years characterized by the same ENSO phase. Such inconsistency reduces the EASM predictability based on ENSO. Results in this study show that the Tibetan Plateau snow cover (TPSC) exerts a modulating effect on ENSO teleconnections and ENSO significantly correlates with the EASM only during the reduced TPSC summers. Three-dimensional circulation structures are examined to manifest that the typical ENSO signals in reduced TPSC summers tend to be stronger than in excessive TPSC summers. Numerical and theoretical evidences indicate that the anomalously reduced TPSC can force positive geopotential height anomalies at the upper troposphere and weaken the jet streams across eastern Asia and northwestern Pacific. Governed by such basic state zonal flows, the extratropical Rossby wave response to the ENSO forcing usually has a larger amplitude and pronounced westward development. In such case, ENSO extends its influences to the eastern Asia and enhances its connection with the EASM.

A critical humidity threshold for monsoon transitions

Jacob Schewe

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Abstract: Monsoon systems around the world are governed by the so-called moisture-advection feedback. Here we show that, in a minimal conceptual model, this feedback implies a critical threshold with respect to the atmospheric specific humidity q_o over the ocean adjacent to the monsoon region. If q_o falls short of this critical value q_{oc}, monsoon rainfall over land cannot be sustained. Such a case could occur if evaporation from the ocean was reduced, e.g. due to low sea surface temperatures. Within the restrictions of the conceptual model, we estimate q_{oc} from present-day reanalysis data for four major monsoon systems, and demonstrate how this concept can help understand abrupt variations in monsoon strength on orbital timescales as found in proxy records.

Near-term climate prediction: new opportunities and challenges

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Abstract: There is currently much excitement in near-term or decadal prediction, with a large effort being made in support of the upcoming IPCC AR5. Decadal prediction aims to close the gap between centennial-scale climate projections and shorter seasonal predictions to deliver more skillful predictions of near-term regional climate change. This presentation will discuss the feasibility of this.

First, I will outline the basis for making decadal prediction, and summarize the skill of current prediction systems. The extra-tropical North Atlantic is one area where models agree that upper ocean circulation and heat content, and sea surface temperature can be predicted with skill up to ten years in advance. This skill results from the initialization of the ocean and exceeds that of radiative forced changes. The ability to predict oceanic changes in this region could have major implications for management of marine resources. Apart from the North Atlantic, there are also some indications of predictive skill in the Pacific, and these will also be discussed.

Second, despite promising early results, large uncertainties exist that limit prediction skill. To illustrate this I will present examples for the North Atlantic on inter-model differences in simulated variability, and the response to external forcing. The accuracy of initial conditions is also a problem.

Third, I will highlight one area where important progress is being made: ocean-atmosphere coupling and the role of the stratosphere. Whether better resolving stratosphere-troposphere coupling can enhance predictability in the North Atlantic sector will be discussed.

Decadal Variability of ENSO Predictability

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(PMEL)

Abstract: Seasonal climate prediction, especially for the monsoons, depends strongly on the capability to predict ENSO and its teleconnections to the monsoons. Here we report on variations of ENSO forecast skill with the BoM coupled ocean-atmosphere forecast model, for which we have generated hindcasts for the period 1960-2010. Seasonal predictability of ENSO derives primarily from upper ocean initial conditions, so forecast skill is limited, in part, by the quality of the ocean initial conditions available to the forecast model. Despite the recent dramatic increase in ocean observations (primarily from ARGO), the forecast skill for predicting ENSO events is found to be dramatically lower in the most recent decade (2001-2010) compared to the previous two decades (1981-2000), and lower even than the earlier two decades (1960-1979) when there was a dearth of ocean observations. We argue that the low skill in the recent decade reflects a recent reduction of ENSO predictability, and this reduced predictability is attributed to decadal changes in the coupled mean state. Post 1998, the coupled mean state has not favoured ENSO variability in the central-eastern Pacific, but rather has promoted ENSO variability further to the west (e.g. Modoki ENSO). The underlying mechanisms for this change in ENSO behavior and the implications for decadal prediction of ENSO and its teleconnection to the monsoon will be discussed.

Interdecadal Change in the Relationship between ENSO and the Intraseasonal Oscillation in East Asia

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Abstract: Regarding the northward-propagating characteristics, the boreal summer ISO is not trapped in the tropics and exhibits a significant signal in the extratropics, especially over the WNP region in many studies. Yun et al. (2008) recently showed that the boreal summer NPISO over the EASM region was significantly affected by the preceding winter ENSO, unlike the insignificant relationship between the winter ISO activity and ENSO (Hendon et al. 1999; Slingo et al. 1999). They reported a possible link to the springtime Indian Ocean sea surface temperature (SST) warming via Walker circulation. This warming induces a suppressed convection over the Philippine Sea, which then induces an anomalous western North Pacific subtropical high (WNPSH), leading to a Rossby wave train and enhanced NPISO activity over Korea and Japan. The northward-propagating intraseasonal oscillation (NPISO) during the boreal summer is closely linked to the onset/retreat and intensity of the East Asian summer monsoon (EASM). In this study, interdecadal variability in the relationships between the NPISO and El Niño–Southern Oscillation (ENSO) was investigated using long-term outgoing longwave radiation data obtained from the 40-yr ECMWF Re-Analysis (ERA-40) for a long-term period. It was found that before the late 1970s, the preceding winter ENSO influenced the early summer (i.e., May to June) NPISO activity, whereas after the late 1970s a strong relationship appeared during the later summertime (i.e., July to August). The May–June NPISO before the late 1970s was modulated by springtime Indian Ocean sea surface temperature warming and central North Pacific suppressed convection anomalies and was consequently related to the ENSO-induced west Pacific (WP) pattern, which shows a north–south dipole structure over the North Pacific from winter through spring. After the late 1970s, because of an anomalously strengthened Walker–Hadley circulation, Indian Ocean SST warming was significantly maintained until summer, which promoted a strong suppressed convection anomaly over the Philippine Sea during summer and consequently an enhanced western North Pacific subtropical high and Pacific–Japan (PJ) pattern.

Multi-decadal variability of Indian summer monsoon rainfall and associated global features of Atmosphere and Ocean

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Abstract: During 1871 to 1990 Indian Summer Monsoon Rainfall (ISMR) had decadal scale variability of period about 60 years, each cycle composed of 3 decades of high mean and low inter-annual variability of ISMR (WET epoch) followed by 3 decades of low mean and high inter-annual variability of ISMR (DRY epoch). DRY epochs were 1901 to 1930 and 1961 to 1990 and they had monsoon droughts on average once in three years, whereas WET epochs 1871 to 1900 and 1931 to 1960 had drought monsoons only once in about 15 years. Using the available network having a smaller number raingauge stations over India we found that 1841-1870 was a DRY epoch. During the DRY epoch 1961-1990 reanalysed wind data showed that subtropical westerlies of the upper troposphere moved to lower latitudes over south Asia as a wave number-3 trough. During this epoch Sea Surface Temperature (SST), monsoon convective heat source and mid-latitude upper tropospheric westerly winds interacted with each other leading to large inter-annual variability of ISMR. Convective heat source anomalies had large east – west oscillations inter-annually between Indian and west Pacific oceans. These heat sources are hypothesised to generate large amplitude wave number-6 Rossby waves in the mid-latitude westerlies which had opposite spatial phase in years of excess and deficient ISMR.

Analysis of SST time series showed that during DRY (WET) epochs, SST anomalies were negative (positive) over areas in Pacific and Atlantic oceans between latitudes 30N and 60N and the tropics to high latitude SST gradients over these oceans were large (small). The SST variation in the Pacific ocean (Atlantic ocean) is the well known Pacific Decadal Oscillation - PDO (Atlantic Multi Decadal Oscillation - AMDO). Decadal oscillations in ISMR and PDO/AMDO had about the same period and temporal phase. Can the large SST gradient phase of PDO/AMDO induce westerly intrusions over south Asia and create large inter-annual variability of monsoon? There seem to be modelling support for this in respect of AMDO.

Upper tropospheric circulation indices have shown that since 1950 the mid-latitude westerly wind regime had a long term trend of movement to lower latitudes over south Asia which it is feared will change the alternating DRY-WET epochal pattern of 1841 to 1990 and create frequent monsoon droughts in India in the coming several decades. Recent monsoon droughts of 2002, 2004 and 2009 in an expected WET epoch beginning in 1990 are taken as indicators of this change.

Decadal Global Monsoon in CCSM3

Hua Chen and Edwin K. Schneider

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Abstract: This study examines the low frequency variability of the regional monsoons (American and Asian monsoons), and discusses their relation to the major modes of the internally generated decadal-to-multidecadal variability in the Atlantic, including Atlantic Multidecadal Variability (AMV) and Atlantic Meridional Overturning Circulation (AMOC), on the basis of a 300-year 1990 control simulation made with CCSM3. The variability of monsoon indices and the structures, amplitudes and time scales of the low frequency Atlantic modes from the control simulation are compared with those from the observation, indicating that CCSM3 is appropriate in this study. The relationship between the regional monsoons and these modes is also captured in the model. To investigate it, the method of interactive ensemble is applied to the model (IECCSM3: 6 copies of AGCMs coupled to the OGCM through the flux coupler), in which weather noise forcing is greatly removed. The regional monsoons and the low frequency modes in the Atlantic are studied and their relationship is rarely seen in the IE-CCSM3. Another set of IE simulation with the weather noise forcing applied to the ocean model of the IE-CCSM3, including the noise net heat flux, noise wind stress and noise freshwater flux, could reproduce the monsoon variability, the Atlantic low frequency modes and their relations from the control simulation. Our results demonstrate that weather noise forcing is of great importance in the relationship between regional monsoons and the decadal-to-multidecadal variability in the Atlantic.

Decadal change in relationship between Spring Arctic Oscillation and East Asian summer monsoon in the late 1990s

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Abstract: A remarkable decadal change in relation of Spring Arctic Oscillation (SAO) and East Asian summer monsoon (EASM) occurs in the late 1990s. The correlation coefficient between positive SAO phase and the time series of the first leading mode of EASM is 0.70 before the late 1990s, but -0.56 after the late 1990s. Following a spring positive AO phase, an anomalous cyclonic circulation before the late 1990s but an anomalous anticyclonic circulation after the late 1990s dominant the lower troposphere over South China Sea-Philippine Sea region in summer, which directly causes the opposite correlations between SAO and EASM. The reasons for the distinct circulation anomalous before and after the 1990s are comprehensively discussed.

The effect of interdecadal variation of East Asian monsoon leading mode in the past 30 years on South China precipitation and Its possible causes

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Abstract: Based on the multivariate empirical orthogonal function (MV-EOF) analysis, an interdecadal turning of the East Asian monsoon in the past 30 years was revealed, and in this context，the interdecadal change of South China precipitation and its possible mechanism were investigated, conclusions are as follows: 1) The leading modes of the East Asian monsoon not only in summer but also in spring are of an interdecadal turning around 1993. 2) The interdecadal turning of leading modes results in an obvious interdecadal seasonal invert change in South China precipitation: the rainfall is reduced in spring and increased in summer, respectively. 3) The atmospheric heat source over the Lake Baikal region in summer and over the Tibet region in spring are both interdecadal changed at the very same year. The interdecadal weakening of Tibet heating is the main cause of the interdecadal reducing rainfall in spring over South China; while the interdecadal changing of the dipole distribution of the atmospheric heat source in Summer over Lake Baikal excited an anomalous anticyclone, thus hindered the summer rain belt moving northward, and results in increased rainfall in summer over South China.

Keywords: interdecadal change in 1993; East Asian monsoon leading model; South China rainfall

Interdecadal variability of the Indian monsoon in an atmospheric general circulation model

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Abstract: Interdecadal variability is studied in with the National Centers for Environmental Prediction (NCEP) seasonal forecast model (SFM) in Atmospheric Model Intercomparision Project (AMIP) style simulations. The model captures most extremes of Indian rainfall. One of the major processes that control the strength of monsoons in an AGCM simulation is the parameterization of deep clouds. A factor that governs the effect of deep convection in the model is the cloud relaxation time scale. Our previous studies have shown that with larger as well as cloud type dependent relaxation time scales, the simulation of mean monsoon rainfall improves. In the present study we try to understand the role of deep convection on the simulation of interannual and interdecadal variability of the monsoons by varying the cloud relaxation time scales in cumulus parameterization.

Variability of the Indo-Australian Monsoon and the Tropospheric Biennial Oscillation

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Abstract: The Tropospheric Biennial Oscillation (TBO) provides some predictability of monsoon intensity based on the intensity of the previous monsoon (Meehl 1997). It involves numerous land-ocean-atmosphere interactions, some of which are still not fully understood. The TBO is known to undergo strong multi-decadal modulations possibly related to decadal time-scales SST variability associated with the Interdecadal Pacific Oscillation (IPO, Meehl and Arblaster 2011). In this study, we analyze how well the TBO is captured in simulations of the historical period produced in the context of the Coupled Model Intercomparison Project, Phase-3 and Phase-5 (CMIP3 & CMIP5). We assess how well the models are able to simulate the numerous processes thought to be involved in the transitions between different states of the TBO. This includes an examination of the relationship between TBO variability and ENSO variability. To analyze the inter-decadal variability, we investigate the consistency of monsoon properties across several ensemble 150-year simulations of a single model, and also across 60 CMIP models and 7 reanalysis.

Interdecadal variability of western North Pacific summer monsoon through the Pacific-Japan (PJ) pattern

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Shang-Ping Xie (Univ. of Hawaii IPRC)

Abstract: The Pacific-Japan (PJ) pattern is known as a basic pressure pattern during summer over the western North Pacific and is correlated to hot and cold summer in Japan (Nitta 1987, Koasaka and Nakamura 2006). The PJ pattern is also known as a remote response from interannual variability of warm anomaly of summer Indian Ocean after the El Niño which suppresses the convection over Philippines and enhances Baiu/ Meiyu activity (Xie et al. 2009). In this study, we defined the new PJ pattern index using station data and reproduced the PJ pattern from 1897 to 2009, and investigated the interdecadal variability of summer monsoon activity over the western North Pacific. The first mode of EOF analysis using 850hPa vorticity during summer and the PJ pattern using the difference of both major pressure seesaw points of Yokohama and Hengchun during summer are correlated well of 0.80. Therefore the PJ pattern is defined as a difference of surface pressure data between Yokohama and Hengchun. PJ pattern and the preceding ENSO have high correlation after 1970s. However this correlation becomes unclear before 1970s. It is interesting that the correlation between the PJ pattern and ENSO is also high before 1910. The relation with the PJ pattern and summer temperature in Japan and summertime tropical cyclone activity will be also discussed.

On the Inter-decadal variation of Intensity of Tropical Cyclones in the Arabian Sea: role of ocean heat content

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Abstract: The effect of climate change on tropical cyclones has been subject of considerable investigation. Evidence of substantial increase in the intensity of TCs during past few decades is revealed by earlier studies. The possible effect of this increase in TC activity is due to anthropogenically induced climate change is reported in some recent studies. However the increasing trends in the intensity of TC activity and their attribution to rising levels of greenhouse gasses is quite complicate. The incidence of this possible climate change signal in TC activity is difficult to sense as the interannual variability necessitates analysis over longer time periods. Also there were other factors that must influence the intensity of TCs. One of the decisive factors influencing the TC intensity and its intensification is ocean thermal energy in the upper ocean. The latest reports over the Arabian Sea indicated that basin wide decreasing trends in vertical shear caused by simultaneous upward trend in the anthropogenic black carbon and sulphate emissions increase the intensity of pre-monsoon TCs during 1979-2010. In the present study, we have examined the inter-decadal variations of the intense tropical cyclones over the Arabian Sea. For this purpose, we have used long term upper air data derived from the NCEP/NCAR reanalysis and ocean heat content data derived from WOA analysis. We have shown that the recent increase in storm strength is a part of natural inter-decadal variability of vertical wind shear observed over the Arabian Sea basin. In addition, the ocean heat content over the Arabian Sea has increased during the recent decade and since 1993, the ocean heat content has increased by 0.4 $KJcm^{-2}yr^{-1}$. The recent increase in the tropical cyclone heat potential (TCHP) over the Arabian Sea is also responsible for the observed trend in storm strength. This increase in TCHP implies a warmer upper ocean, which helps TCs to sustain or increase its intensity by uninterrupted supply of sensible and latent heat fluxes from the ocean surface to the atmosphere.

Influence of Indian Ocean Dipole and Pacific recharge on next year's El Nino: interdecadal robustness

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Abstract: Better understanding the onset of El Nino/La Nina events is crucial to improve their seasonal forecasts, but remains a challenging issue. In addition to the usual preconditioning through equatorial Pacific Warm Water Volume (WWV) recharge, the Indian Ocean Dipole (IOD) has been recently suggested to also affect the El Niño-Southern Oscillation (ENSO) state of the following year, through modulation of the Walker circulation and oceanic wave dynamics similar to the delayed oscillator (in a study based on the recent satellite era and on models; Izumo et al., 2010a). Here we investigate the interdecadal robustness of this scenario, spatial and spectral differences in predictability between IOD and WWV influences, and test other possible influences on ENSO such as monsoon, over a much longer period (1870s-2000s).

First we develop an improved IOD index that fully exploits the sparse historical observations of the Indian Ocean through regression. We then show that equatorial Pacific zonal windstress, when temporally integrated and filtered, is an efficient proxy of WWV interannual variations. Using these IOD and WWV indices through linear regression allow to explain (and hindcast) half of following ENSO variance, with both influences remaining significant over most of the historical period, for El Nino as well as La Nina onset cases: e.g. negative (positive) IOD tends to induce El Niño (La Niña) the following year. The IOD is also a more robust ENSO predictor than uniform basin warming/cooling of the Indian Ocean, the Indian Monsoon or ENSO itself. Analysis of a 200 years-long coupled general circulation model also confirms that, despite some decadal fluctuations, the IOD and WWV influences on following ENSO almost always remain significant. Furthermore, IOD-related predictability seems to be of higher frequency and within a narrower latitudinal equatorial band than WWV.

Based on these results and detailed analyses of teleconnections, we propose a conceptual scheme of Indo-Pacific interactions that slightly differs from the Tropical Tropospheric Biennial Oscillation (TBO) or Webster and Hoyos (2010) framework. The IOD-ENSO interactions would favour a biennial timescale, and interact with the slower recharge-discharge cycle intrinsic to the Pacific Ocean. The Indian Monsoon would respond rather passively to the IOD-ENSO coupled system. This idealised scheme can be represented by year-to-year recurrent relationships that lead to an autoregressive equation of order 3 for ENSO. This study highlights the need to better observe and simulate the Indian and Pacific oceans and their interactions.

Decadal variability of the Australian monsoon and future projections as represented in CMIP5 models

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Abstract: Although populations affected by the Australian monsoon are much smaller than those affected by the South and East Asian monsoons, regional impacts of changes in monsoon timing or strength are nevertheless likely to be large, particularly on vulnerable indigenous populations and sensitive ecosystems. The strength of the Australian summer monsoon is known to vary naturally on interannual and decadal time scales, with recent trends towards increased rainfall in the north-west attributed, at least partially, to anthropogenic aerosol forcing. We report on the simulation of decadal variability of Australian monsoon rainfall in CMIP5 models, focusing on the rainfall response to the Interdecadal Pacific Oscillation (IPO) in historical climate. We also investigate changes in monsoon rainfall in future climate simulations under the high emission "RCP8.5" scenario, considering both mean changes and changes in the amplitude of decadal variability. Projections of the Australian monsoon response to a warming climate in CMIP5 models show little change in mean summer rainfall over tropical northern Australia, consistent with results from CMIP3 models. While future changes in Australian summer monsoon rainfall due to thermodynamic processes (increased atmospheric moisture) are generally positive, those due to dynamic process (changes in circulation) are more uncertain and vary from model to model.

Evidence of Coordinated Weakening of the Asian and West African Monsoons and Links to North Atlantic Cooling

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Abstract: Previous modeling and palaeoclimate studies have suggested that cooling originating from the extratropical North Atlantic can weaken the West African, South Asian and East Asian monsoons. The climatic signature includes a widespread cooling over the Eurasian and North African continents and an associated increase to surface pressure. Motivated by these studies, it is explored whether such coordinated changes are similarly exhibited in the observed twentieth-century climate, in particular, with the well-documented shift of Sahel rainfall during the 1960s.

Surface temperature, sea level pressure, and precipitation changes are analyzed using combined principal component analysis (CPCA). The leading mode exhibits a monotonic shift in the 1960s/70s, and the transition is associated with a relative cooling and pressure increase over the interior Eurasia and North Africa, and rainfall reduction over the Sahel, South Asia, and East Asia. The local circulation changes suggest that the rainfall shift results from the regional response of the summer monsoons to these continental-wide changes. A similar CPCA analysis of atmospheric general circulation model (AGCM) simulations forced by twentieth-century-observed forcings shows similar results, suggesting that origins of the climate shift reside in the sea surface temperature changes, especially over the extratropical North Atlantic. Finally, an AGCM forced with extratropical North Atlantic cooling appears to simulate these climate impacts, at least qualitatively.

The result herein shows that the observed climate signature of the 1960s/70s shift in Eurasian and North African climate is consistent with the influence of the high-latitude North Atlantic cooling that occurred in the late 1960s. A definitive causal relationship remains to be shown, and mechanisms elucidated.

Interdecadal linkages between Pacific decadal oscillation (PDO) and interhemispheric air mass oscillation (IHO) and their possible connection with east Asian Monsoon

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Abstract: The Pacific decadal oscillation (PDO) recently emerged in the literature as a robust signal in the Northern Hemisphere climate variability. Many previous studies reported that the relationships between PDO and east Asian monsoon (EAM) and climate variability in China are significant. However, their possible mechanism is still unclear. Using the observational NCEP/NCAR reanalysis and Chinese station data during the period of 1969-2008, the present study investigates the interdecadal relationship between Pacific decadal oscillation (PDO) and interhemispheric air mass imbalance or oscillation (IHO) between the Northern Hemisphere and it counter part in the Southern Hemisphere. The possible connection of PDO and IHO with both east Asian monsoon and climate variability in China are also assessed in this study. It is found that the interdecadal component (11-38 years) of PDO and IHO and EAM contribute large variance to low frequency, and they are well-matched with each other. In particular, their negative phases mainly show in the 1970s and late 1990s, while positive phase display from 1980s to mid 1990s. The spatial distributions of PDO and IHO associated surface air temperature and surface pressure anomalies exhibit highly similar and large scale global-scale characteristics, indicative of their intimate linkage with air mass redistribution over global domain especially over 30^0S-60^0N. The PDO associated columnar integrated velocity potential anomalies which maintaining the air mass redistribution, show a dipole pattern with air mass flux output mainly from the eastern hemisphere to the Pacific regions in positive PDO phase, vice verse. This contributes to hemispherical and land-sea mass exchange and redistribution, and also leads to the decadal displacement of both upward and downward branch of Walker circulation. Along with PDO in its positive phase, an anomalous anticyclone exhibits in the Mongolian region in both boreal summer and winter seasons. Resultantly, significant anomalous northerlies emerge in the eastern China, and thus intensify (weaken) the east Asian winter (summer) monsoon. It is also found that the simultaneous correlation between temperature and precipitation interdecadal change in mostly east China stations and the Pacific decadal oscillation index are well-defined especially in the southern China, Yangtze River and northern China regions.

Keywords Pacific decadal oscillation (PDO), Interhemispheric oscillation (IHO), east Asian monsoon, decadal change, climate variability in east China

Multi-Decadal Variability of West African Rainfall and Atlantic SSTs in CMIP5 Simulations

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Abstract: Rainfall in the Sahel region of Africa shows a large multi-decadal signal, transitioning from wet conditions in the 1950s and 60s to dry conditions in the 70s and 80s and appearing to recover back to wet conditions during the 90s and 00s. This multi-decadal signal has been attributed to SSTs in the Atlantic (associated with the Atlantic Multi-decadal Oscillation - AMO) and other regions of the globe. The mechanisms linking the AMO and Sahel rainfall throughout the annual cycle are investigated and show an increased monsoon flow, stronger Saharan heat low and increased African easterly wave activity during the warm phase of the AMO. This study uses output from the 20th century (historical) and control CMIP5 modeling simulations to investigate the ability of the CMIP5 models to capture the mechanisms linking the AMO and rainfall in the Sahel. Initial results indicate that the majority of models produce multi-decadal variability in the North Atlantic SSTs (AMO) as seen in observations. While these models produce a multi-decadal signal in Sahel rainfall, the amplitude of this signal is weak, with errors in the spatial structure evident when compared to observations. Investigation into mechanisms in successful and unsuccessful model simulations will be shown in order to aid in the interpretation of the CMIP5 decadal prediction simulations.

The South Asia High Reconstruction Processes from April to May and its Relationship with the Convective activities over the Indo-China Peninsula

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Abstract： Using pentad NCEP/NCAR reanalysis, OLR and CMAP precipitation dataset, the features of South Asia High(SAH) reconstruction process during April and May from 1979 to 2008 is investigated. We found there exist 21 years in process of SAH reconstruction which characterize with strengthening of SAH's western center located in Indo-China Peninsula and decaying of SAH's eastern center in western Pacific nearby east of Philippine. Due to these reconstructions' significant interannual variability, normal years, early years and late years of reconstruction are selected according to their starting date. In normal years, active convection located between 10ºS and 10ºN before reconstruction process; during the reconstruction stage, active convection extend from maritime continent to Indo-China Peninsula. In early(late) years, strong convection expanding to Indo-China Peninsula is earlier(later), indicating that there exist intimate connection between typical SAH reconstruction staring date and developing date of strong convection in Indo-China Peninsula. The starting date of rain belt and diabatic heating center entering SAH's western center are consistent with the process of SAH reconstruction. Thus, latent heating result from convective precipitation is possible reason for SAH's reconstruction in Indo-China Peninsula.

Key words: South Asia High(SAH)；Indo-China Peninsula；reconstruction；convection；precipitation

Orbital-scale Pacific-East Asia teleconnection and anti-phased variations of summer precipitation

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Abstract：Various monsoon proxies obtained in the East Asian region, which covers the past several orbital cycles, show different phase responses. A distinct out-of-phase relationship of summer precipitation is found between southern and northern parts of East Asia. We use a 280ka-long transient run to explore the potential driving mechanism for the anti-phased change in precipitation. In the modeling results, an orbital-scale Pacific-East Asia teleconnection is clearly shown, just like that over the interannual timescale; this explains the observed regional precipitation differences. At NINO3.4 SST maxima, the East Asian summer monsoon strengthens, inducing more precipitation in the north and less precipitation in the south. The SST impact is primarily via the subtropical high pressure anomaly over northwestern Pacific. Thus, the internal ocean feedback can significantly modulate the response timing of Asian palaeo-monsoon to the orbital forcing.

Interdecadal Variability of Surface Winds over China Marginal Seas

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Abstract: Long term variability in the surface winds over the China marginal seas is examined with a dominant-mode singular value decomposition method. Both interannual and interdecadal patterns are found to be seasonally and spatially dependent, with reanalyses and satellite remote sensing data yielding highly consistent results. The study reveals that the summer monsoon wind over the East China Sea experienced an interdecadal regime shift in late 1960s with a drop of wind speed by about 1 m/s. Another regime shift appeared to occur since 2005. The study also finds a gradual weakening of winter monsoon in the southern South China Sea since 1960s, with corroboration from coastal climatic stations in Borneo. The phenomenon has not been noticed in previous monsoon studies.

Keyword: China marginal seas; monsoon; interdecadal variability; dominant mode

Typhoon Track Changes Associated with Global Warming

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Abstract: Increasing tropical cyclone (TC) influence in the subtropical East Asia and decreasing TC activity in the South China Sea over the past decades have been previously reported. The singular value decomposition (SVD) of observational data and the Intergovernmental Panel on Climate Change (IPCC) climate change simulations in the fourth assessment report shows that the observed TC track changes are linked to the leading SVD mode of global sea surface temperature (SST) warming and the associated changes in large-scale steering flows. The selected five IPCC models can generally simulate the leading mode in their ensemble control run and prediction, suggesting the possible persistence of the reported track changes by 2040.

Decadal Changes of Asian Summer Monsoon Onset

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Abstract: Understanding the monsoon onset change is of utmost importance especially for agriculture planning and water management. In the last three decades, Asian Summer Monsoon (ASM) onset has remarkably advanced, but the physical mechanisms remain elusive. Since the overall ASM onset occurs in May, we focus on the change of mean fields in May and consider enhanced mean precipitation and monsoon westerly winds as signs of advanced onset. Results show that the advanced ASM onset mainly represents a robust decadal shift in the mid-to-late 1990s, which is attributed to the mean state change in the Pacific basin characterized by a grand La Niña-like pattern. The La Niña-like mean state change controls the ASM onset through the westward propagation of Rossby waves and its interaction with the asymmetric background mean states in the Indian Ocean and western Pacific, which facilitates the amplification of the northern hemispheric perturbations as well as intensified westerly winds. Intriguingly, the abrupt decadal shifts of monsoon onset in the Arabian Sea and Bay of Bengal occur in 1999, in contrast to the South China Sea with decadal shift in 1994. Numerical experiments demonstrate that the advanced monsoon onset in the Arabian Sea and Bay of Bengal is governed by the enhanced zonal sea surface temperature (SST) gradients in the equatorial Pacific, while that in the South China Sea is primarily determined by the abrupt SST warming near the Philippine Sea.

Influence of Indian Ocean dipole mode on North Indian Ocean tropical cyclones

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Abstract：Using the JTWC tropical cyclone track data over North Indian Ocean (NIO), NECP monthly reanalysis wind and OLR data, and NOAA sea surface temperature data from 1981 to 2010, the temporal and spatial distribution of NIO tropical cyclones and its relationship with Indian Ocean sea surface temperature were studied with statistical diagnosis method. EOF analysis of North Indian Ocean tropical cyclone appearance frequency indicated that the EOF1 mode, which is account for 16% of the total variance contribution, represent the NIO tropical cyclone appearance frequencies have basin-scale consistent variations. However, the spatial distributions of EOF1 mode are inhomogeneity, and mainly reflect the variation of the west-path tropical cyclone tracks in Bay of Bangle. Wavelet analysis showed that the NIO tropical cyclone appearance frequencies EOF1 mode has significant quasi-periodic oscillation of 5-years.

The interannual variation of NIO tropical cyclone activity is notably influenced by Indian Ocean dipole mode (IOD). When Indian Ocean is in positive (negative) phase of IOD, the NIO SST anomaly present for warm in west (east) and cold in east (west), which is weaken (strengthen) the convection over NIO and cause anomalous anti-cyclonic (cyclonic) atmospheric circulation in low level. As a result of unfavorable (favorable) for the tropical cyclone genesis and reduce (increase) the tropical cyclone appearance frequency in NIO. In addition, the positive (negative) IOD events can strengthen (weaken) the westerly steering flow over the Bay of Bangle, which further lead to less (more) west-path tropical cyclones appear in west of 90° E in Bay of Bangle.

Keywords North Indian Ocean; tropical cyclone; interannual variation; Indian Ocean dipole mode

Possible connection between Pacific Oceanic interdecadal pathway and east Asian winter monsoon

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Abstract: This study proposes that the most obvious interdecadal variation of Sea Surface Temperature (SST) anomalies is over the Eastern North Pacific at about 20 N, and this interdecadal pathway (IP) has maximum latent heat flux, which might play an important role in the connection of midlatitude and tropical SST anomalies. Furthermore, depending on the lagged regression of SST anomalies against EAWM, the winter monsoon impacts on the SST anomalies on the decadal timescales. To some extent, the "atmospheric forcing" in the midlatitude acting as the "upstream effect" is much obvious when there is strong EAWM. Our present work highlights the "bridge" role of the IP regions linking the coupled ocean-atmosphere interaction between midlatitude Pacific and the tropical Pacific.

The cause of PDO change has remained controversial. Recent observational and modeling studies indicate that the change in the PDO may depend on the fresh water flux into the outcrops suggested that the slow response of ocean temperature due to anomalous net atmospheric freshwater may play an important role in the PDO or ENSO-induced atmospheric anomalies. In our study, we speculate that through the air-sea interaction over IP region, the change of PDO phase depends on the variation of EAWM amplitude on decadal timescale. That is, when a strong EAWM leading, the cooling phase over PDO regions might be intensified at first few years and then reach a peak. Later the maximum of cooling phase would shift eastward and weaken with the EAWM-induced westward wind stress. Concurrently, the cooling phase over IP regions develops increasingly due to subduction over midlatitude Pacific and leaking from midlatitude Pacific. Further, the warming phase over western Pacific, which is originally from equatorial eastern Pacific, will be brought to the PDO regions by the Kuroshio Current. Thus the PDO phase is marching in a period of at least 10 years. But why the interdecadal variation over IP regions is most significant and what is the physical mechanism responsible for the leaking from PDO region and IP region, remains the subject of ongoing research.

Inter-decadal Changes and Causal Analysis of Meiyu Periods in the Mid –Lower Yangtze Basin during 127 Recent Years (1885- 2011)

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Abstract：Meiyu (plum rain) period is the main rainy period of the mid-lower Yangtze Basin (MLY) with significant inter-annual and inter-decadal changes, which not only reflect the temporal variability of summer monsoon rainfall in the MLY, but also highly correlates to the latitudinal position of the main summer monsoon rainy belt in eastern China both at inter-annual and interdecadal scales; so the change of Meiyu period in the MLY is an important index showing the variability of the summer monsoon rainfall in eastern China. Through analyzing, it was found the inter-decadal changes of the Meiyu rainfall, the onset and ending dates of Meiyu period were significantly effected by the magnetic sunspot cycles of 22 years (Hale cycle), however this solar effect on Meiyu climate has been significantly overwhelmed by the influence of rapidly developing economic of China since the late 1970s, such as the acceleration of industrialization accompanied by an increase in atmospheric pollution and a reduction of the solar radiation reaching the ground, the sand area of North China has also expanded due to overgrazing. Under such worsen environment, a series of abnormal summer climate has appeared: the pentad number of the northward west Pacific high at 500hPa level in section of 110-130 E in JA was decreased accompanied with the delayed ending date of Meiyu period, more Meiyu rainfall and flooding in the MLY, more southerly position of the main rainy belt in eastern China and frequent occurrences of summer droughts in North China during 33 recent years (1979- 2011). Hence we should do our best improving our environment and then also our monsoon climate.

How do coldwaves in China respond to a warming climate?

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Abstract：Under the background of a warming climate, regional climate responses may be different from place to place. How cold extreme events in China respond is still an open question. This study investigates responses of coldwave frequency (CWF) in China from observation and modeling perspectives. Observational evidences show that CWF significantly reduces across China during the warm period (1978–2009) in comparison with that during the cold period (1957–1977), concurrent with extreme value centers located in northern China during 1957–1977 and southern China during 1978–2009. The empirical orthogonal function (EOF) leading mode of CWF in the cold period is also dominant by an extreme value center prevailing over northern China, while the center exhibits a southward shift in the warm period. A seven-member multi-model ensemble (MME) from coupled model intercomparison project#3 (CMIP3) shows that southern China tends to experience more coldwaves than northern China in the twenty first century (2045–2064 and 2080–2099) under the global warming A1B forcing (with atmospheric CO2 concentration of 720 ppm). This feature can also be seen in the leading EOF mode of MME. These results indicate that the primary response of CWF to a warming climate may be the southward shift of the maximum loading center. The response of CWF may be associated with the weakened Siberian High (SH) and the enhanced western Pacific Subtropical High (WPSH) in the warm period. Cold and dry air is transported from the north via a "northwest pathway" to southern China during 1978~2009. Meanwhile the enhanced WPSH and weakened SH may result in anomalous southerlies which bring warm and wet air to southern China. Under the joint action of these two air masses, coldwaves may easily generate in southern China as observed in recent extreme cold events in this region. The variation of the CWF might also be intimately associated with the enhanced and southward shift of the storm track from the cold period through the warm period. Negative correlations are found between coldwaves and the North Pacific storm track. The stronger storm activities in the warm period indicate less coldwaves. The significance change of the baroclinic growth rates around 40° N tends to be accompanied by a consistent change of the synoptic eddies in the troposphere, which may shift the preferred latitude for the growth of eddies. As a result, the storm track tends to move southward, suggesting the possibility of the increased storminess in southern China due to the increased baroclinic instability in the troposphere.

Analysis on the Upper-Air Temperature over Eastern China Under the Background of Global Warming

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Abstract: Based on the monthly dataset of 137 sounding stations in eastern China and 160 ground-based stations in the whole of China in the period of 1960-2009, under the background of global warming, the variation characteristics of the upper-air temperature over eastern China are analyzed. The results show that: 1) since 1980 the relationship between the surface air temperature and the annual average temperature of the each level over eastern China is more and more closer. The upper-air cooling is significantly related with the global warming. 2) Whether the warming rate at the mid-to-lower layer of troposphere or the cooling rate at upper layer of troposphere in the past 30 years, is much more intense than before 1980s. 3) The amplitude of seasonal variation in northern China is larger than in southern China. 4) At the lower level (from surface layer to 300hPa) of eastern China, the temperature has the different responses to the global warming at different regions and different seasons. For the regions, the boundary is 35°N. There is no cooling to the northern of the boundary, vice visa. For the seasons, there is warmer in winter and cooler in summer.

Key words: sounding dataset; temperature variation in the upper and lower levels; global warming

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