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Monsoon Activities in China

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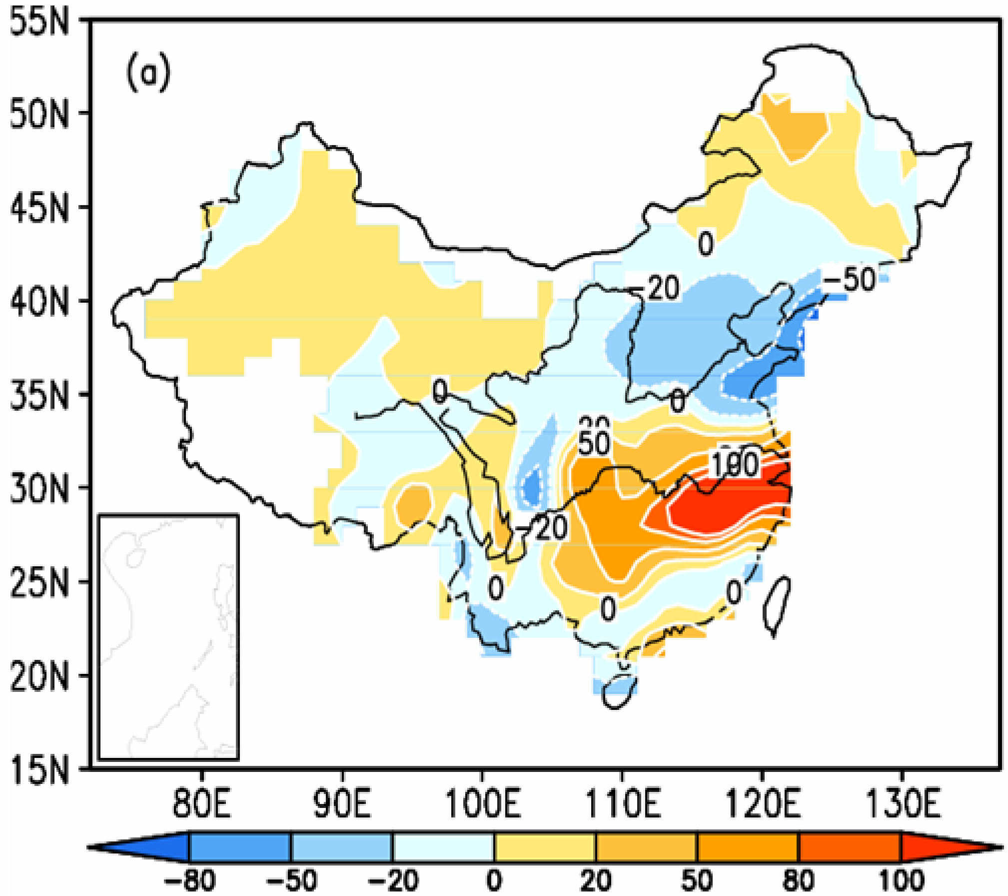
CLIVAR AAMP10, Busan, Korea 18-19 June 2010

Outline

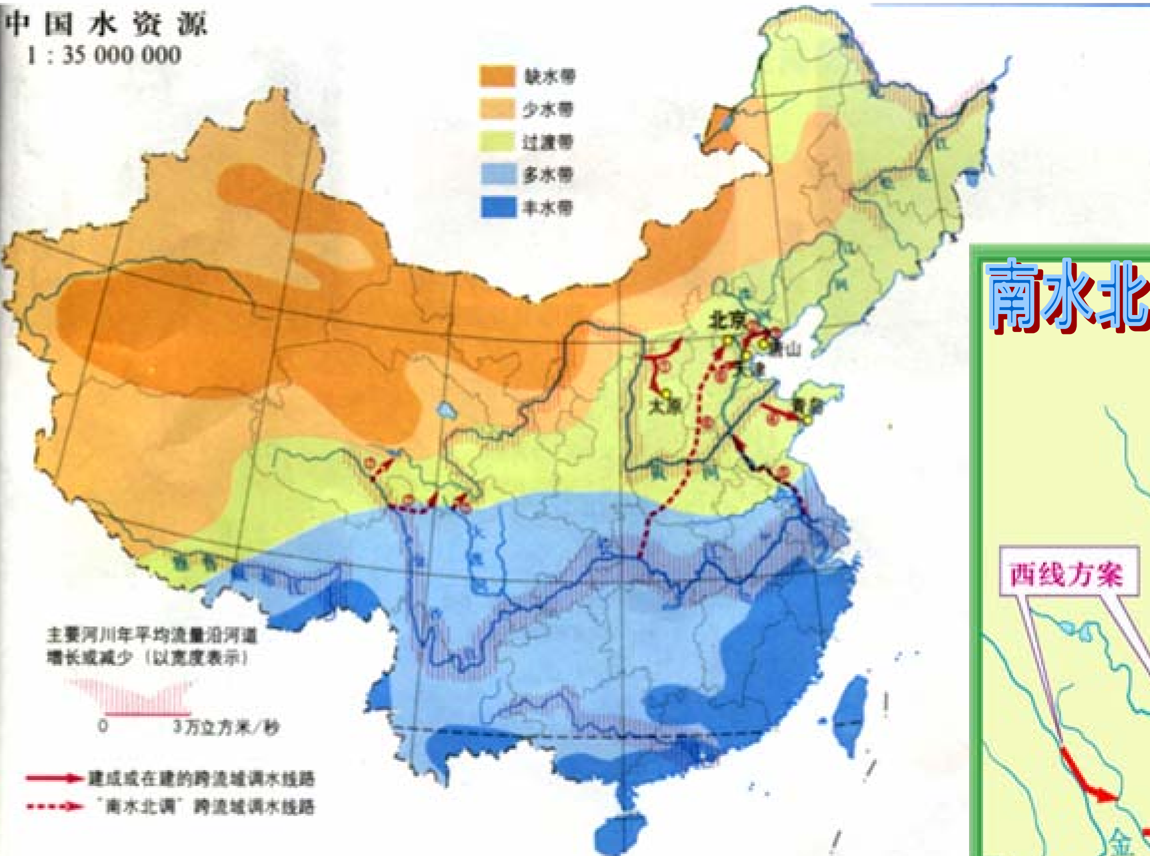
- Variability of EASM
  - -- Interdecadal variability
  - -- Interannual variability
  - -- Diurnal cycle & ISO
- New Projects
- Suggested interactions with AAMP

Focus



Changes of JJA Rainfall (1981-2000 minus 1958-1977)

South-to-North Water Diversion Project



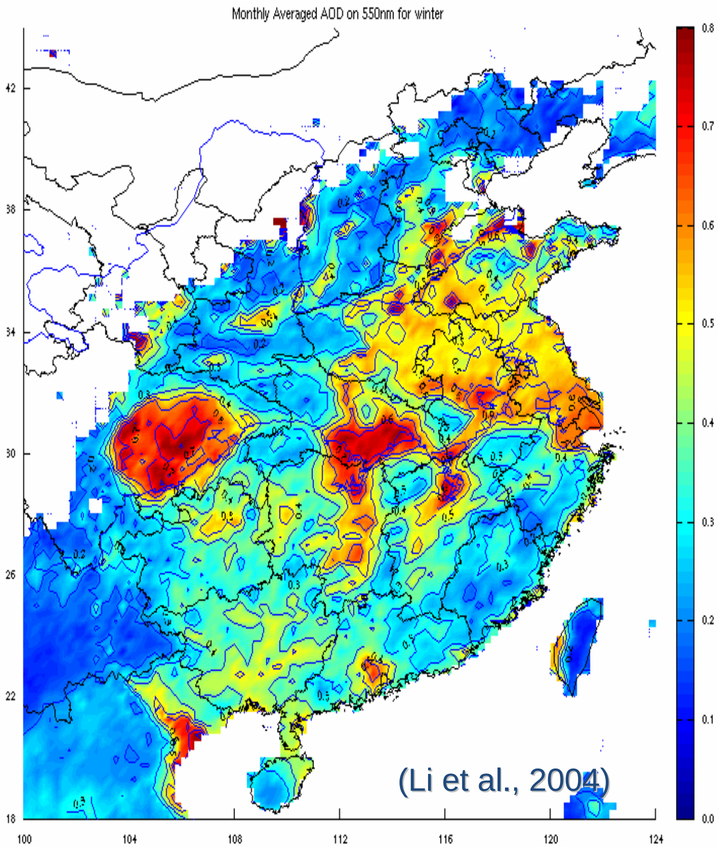
http://www.nsbd.gov.cn/zx/english/

Proposed Mechanisms

- Tropical Ocean warming (Hu, 1997; gong and Ho, 2002; Zeng et al., 2007)
- Tibetan Plateau forcing (Wang et al., 2008;Duan and Wu, 2008)
- Aerosol forcing (Qian and Giorgi, 1999; Menon et al. 2002; Lau et al. 2006)
- Internal variability (Zhu and Wang 2002; Ding et al. 2007a,b)
- ……

(Zhou et al. 2009, *Meteorologische Zeitschrift* for a Review)

Arguments on the mechanism



Optical Thickness of 2001

REPORTS

Climate Effects of Black Carbon Aerosols in China and India

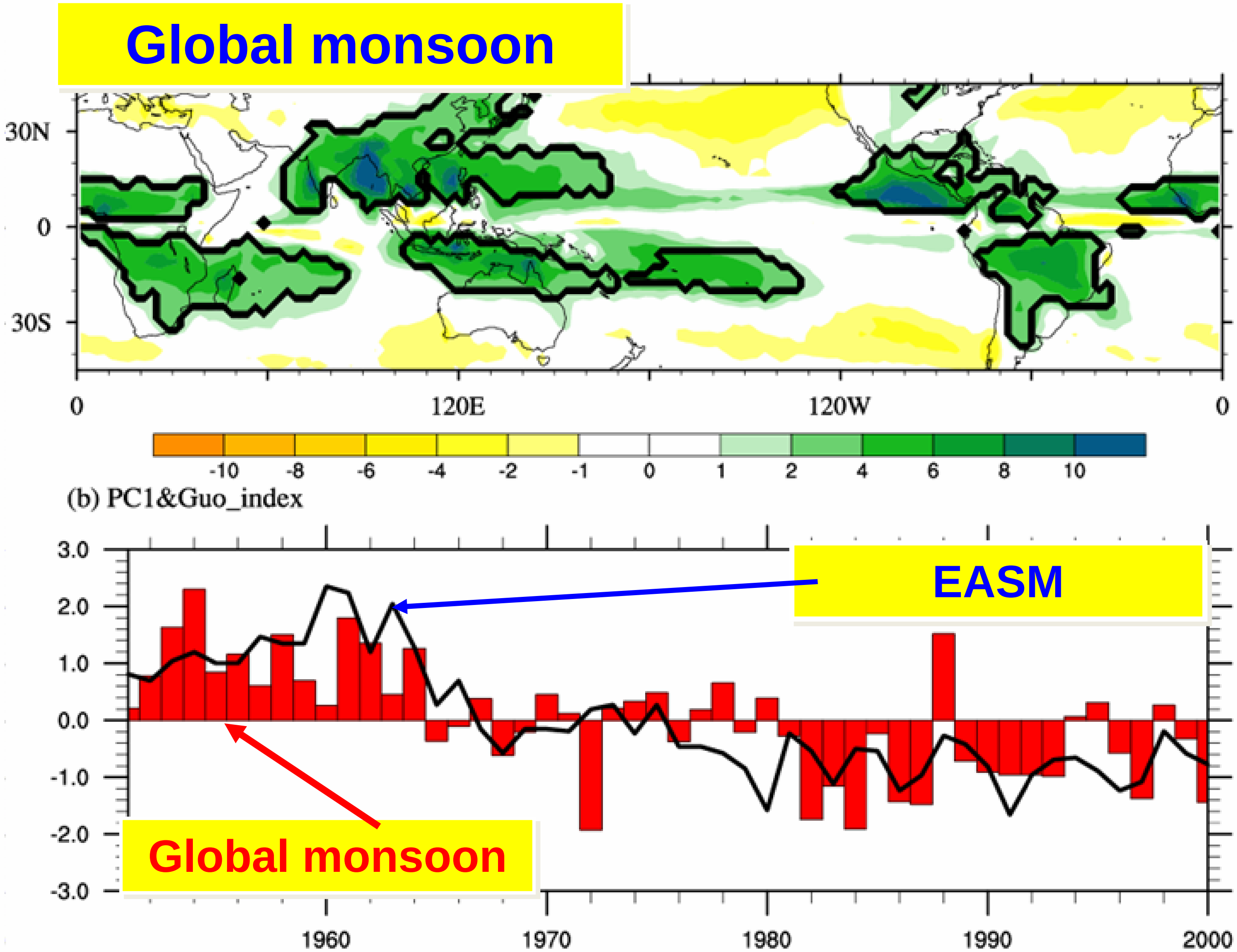
Surabi Menon,[1,2*] James Hansen,[1] Larissa Nazarenko,[1,2] Yunfeng Luo[3]

In recent decades, there has been a tendency toward increased summer floods in south China, increased drought in north China, and moderate cooling in China and India while most of the world has been warming. We used a global climate model to investigate possible aerosol contributions to these trends. We found precipitation and temperature changes in the model that were comparable to those observed if the aerosols included a large proportion of absorbing black carbon ("soot"), similar to observed amounts. Absorbing aerosols heat the air, alter regional atmospheric stability and vertical motions, and affect the large-scale circulation and hydrologic cycle with significant regional climate effects.

2250 27 SEPTEMBER 2002 VOL 297 SCIENCE www.sciencemag.org

SCIENCE 2002

EASM and Global Monsoon



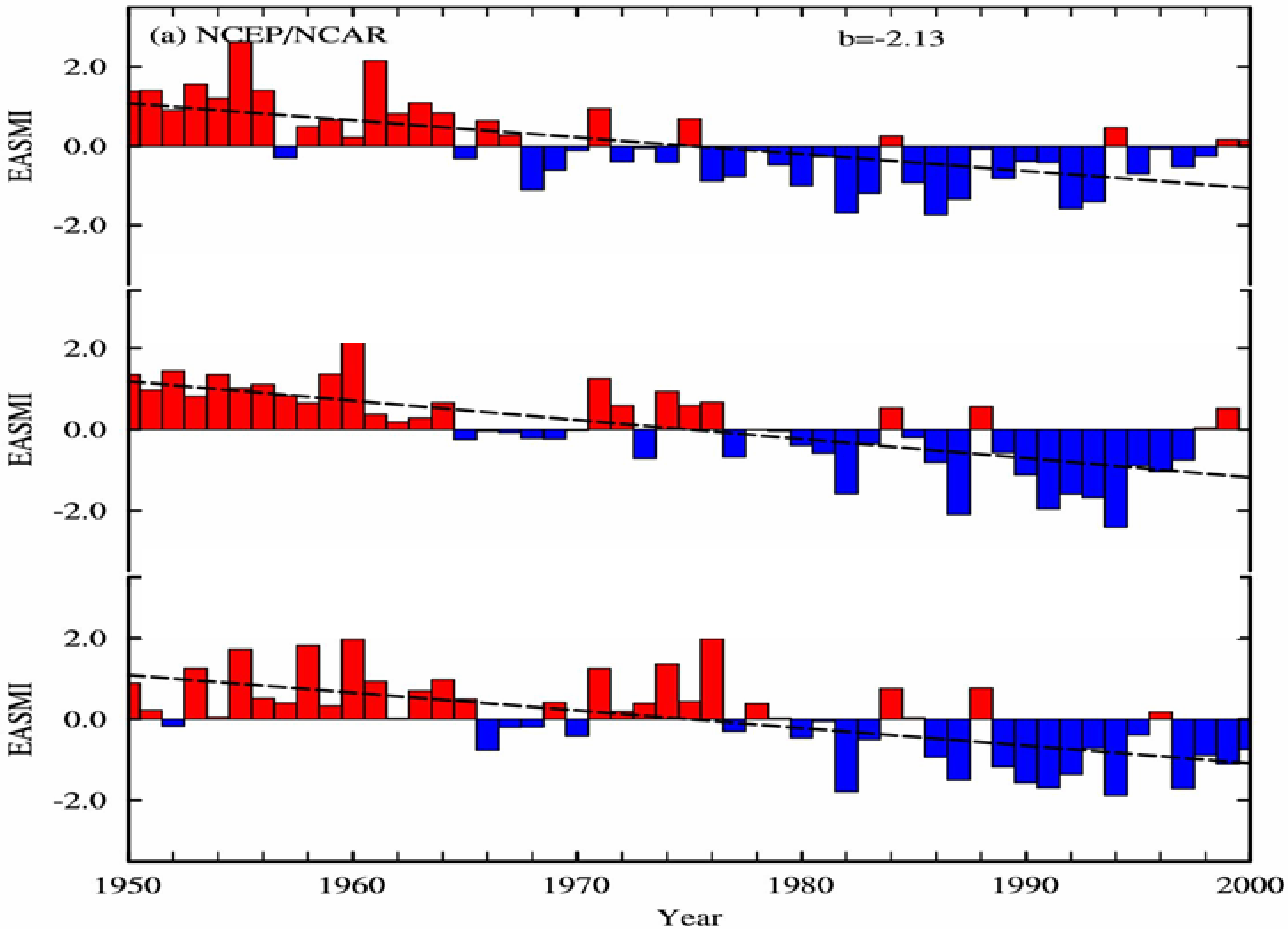
(Wang and Ding 2006 GRL; Zhou et al. 2008 GRL; Zhou et al. 2008a J. Climate)

EASM index in the reanalysis and simulation

Reanalysis

GOGA

TOGA

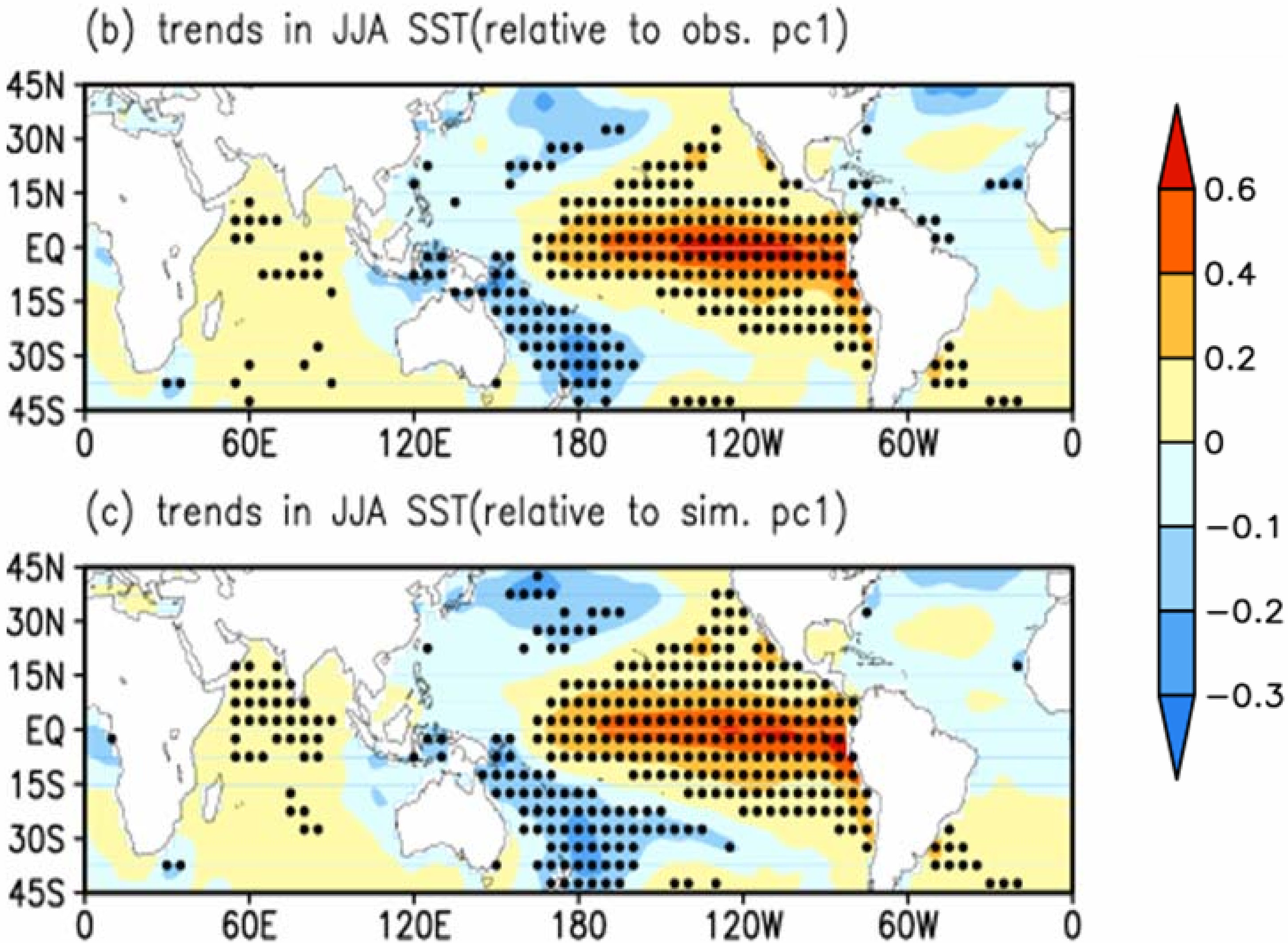


(Li et al. 2010 Clm Dyn)

SSTA related to monsoon weakening

reanalysis

Simulation



(Zhou et al. 2008a J. Climate)

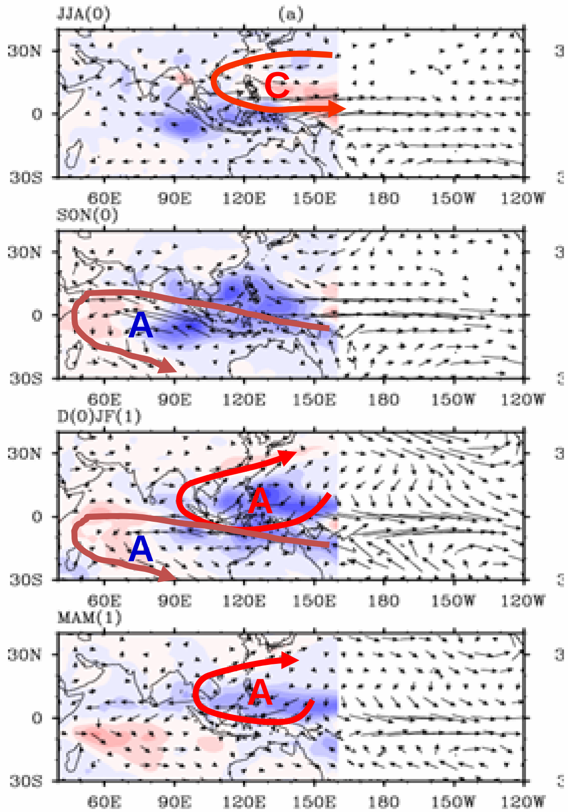
Focus

- The Skill of AMIP models
- The Pacific and Indian Ocean forcing to EAM
- Teleconnection and statistical prediction

Interannual variability modes of AAM

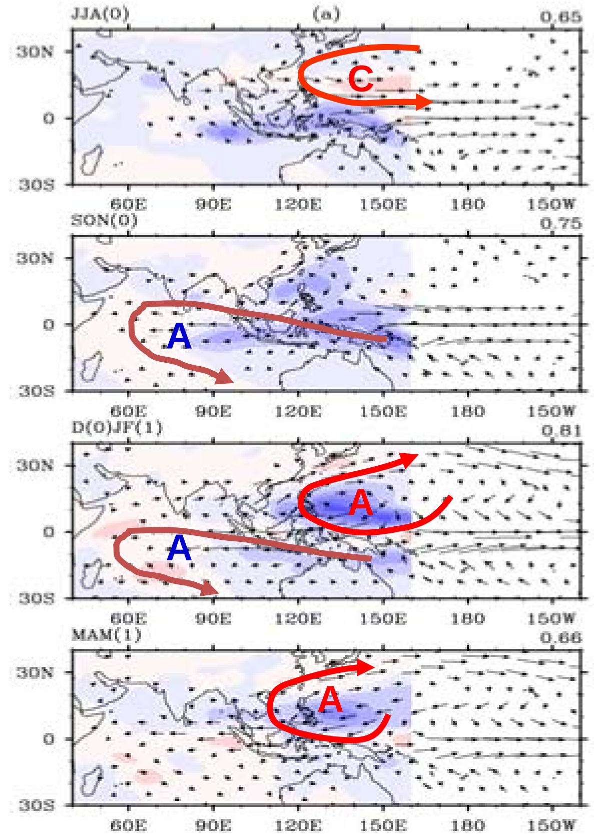
S-EOF analysis; from JJA(0) to MAM(1)

27.4%



OBS

31.3%

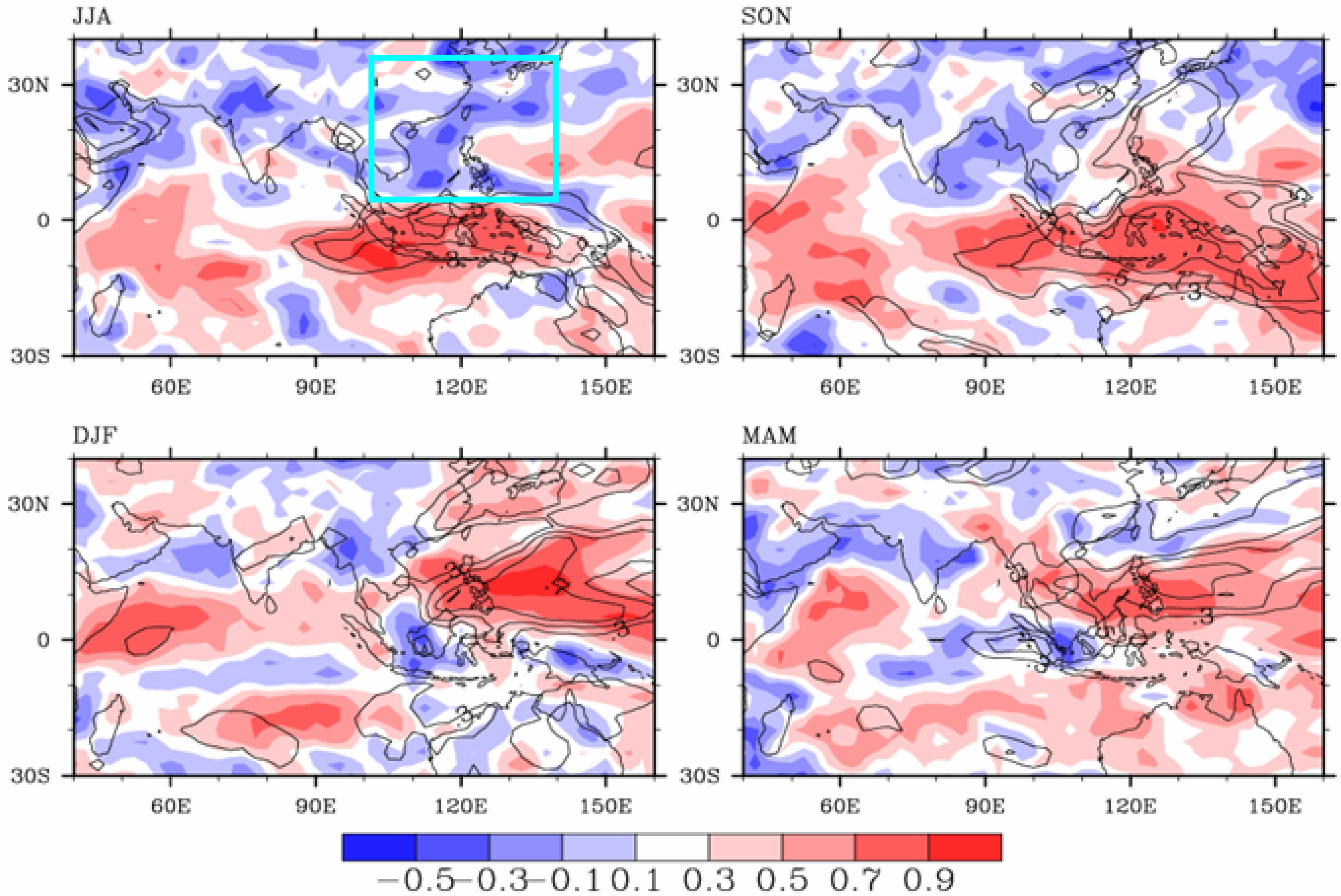


AMIP

Shading - Rainfall ; Vectors – 850 hPa wind

(Zhou et al. 2009a J. Climate)

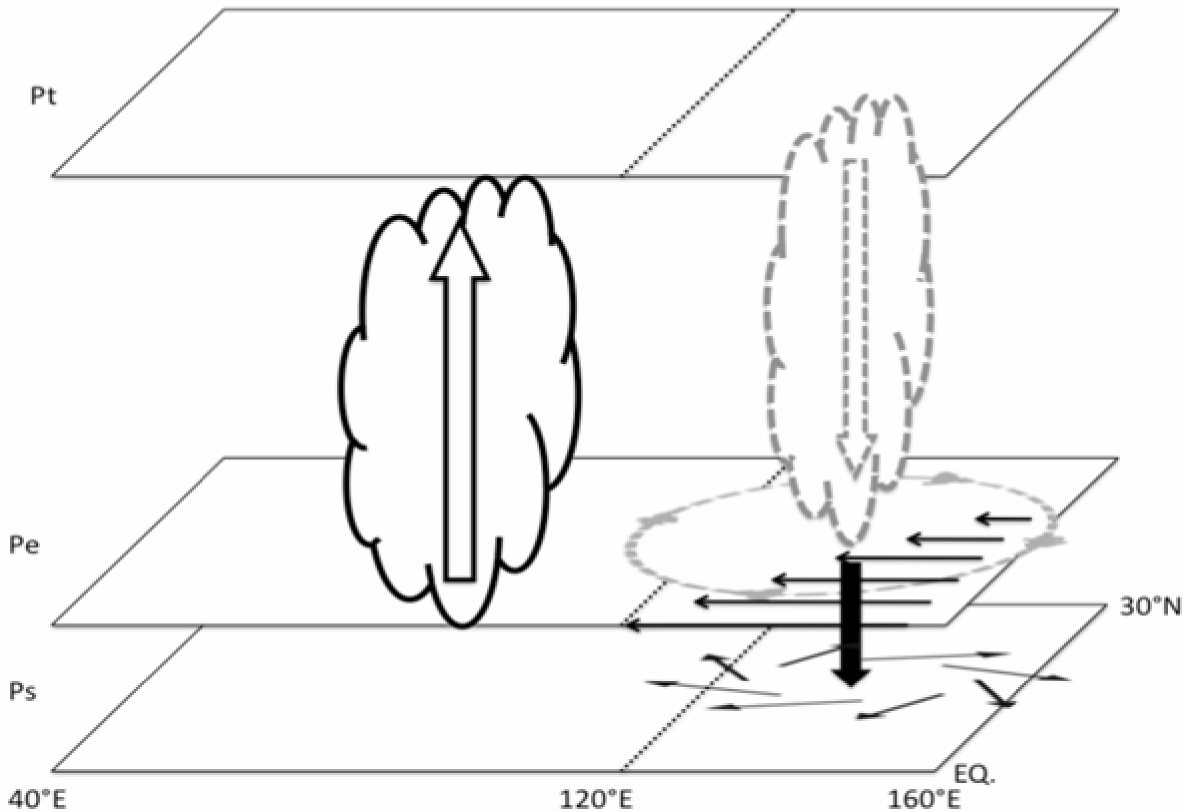
Correlations between observed and AMIP MME rainfall anomalies



- High skill in tropical region
- Nearly no skill in summertime WNP monsoon area.
- Better in winter

(Zhou et al. 2009a J. Climate)

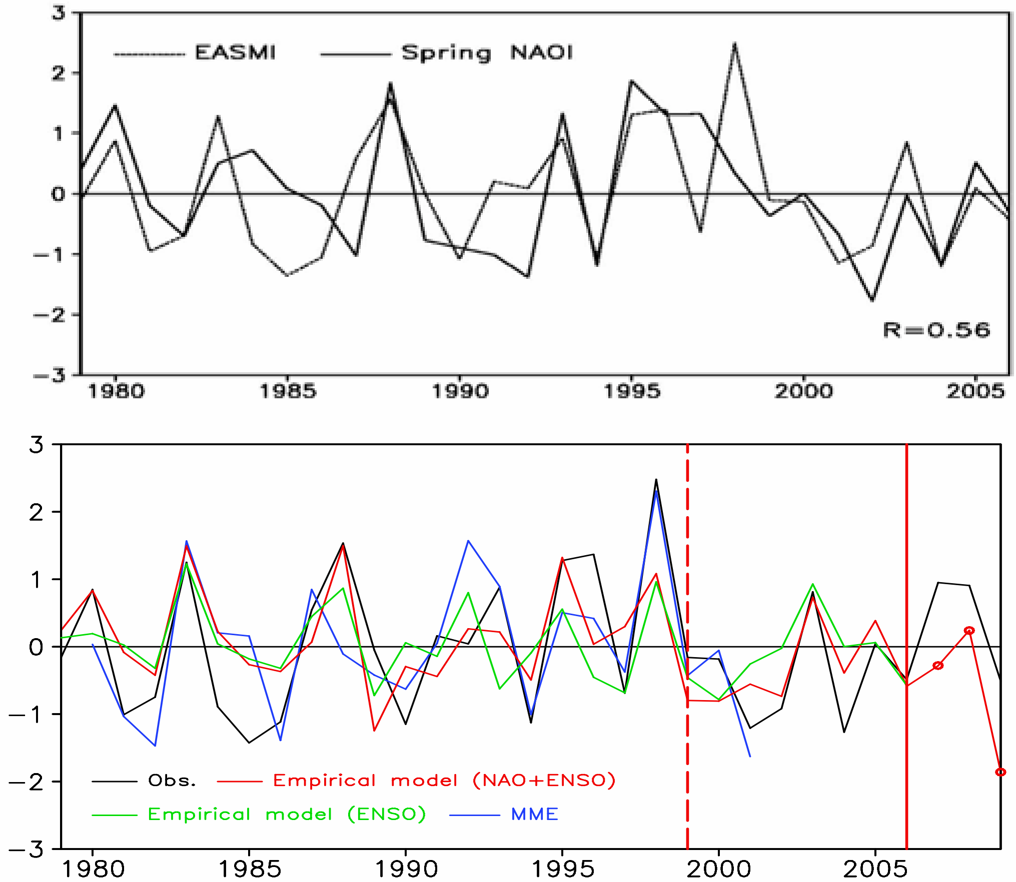
IOBM influences the WNPAC



Wu et al. 2009 J. Climate

- During El Nino decaying summer, the WNPAC in June relies on the negative SSTA in the WNP.
- Following the growth of WNP monsoon trough in July and August, the IOBM impact gradually intensifies and drives the WNPAC in the Philippine Sea through atmospheric Kelvin wave forcing.

NAO and EASM: Empirical Prediction Model



EASM index in Observation, MME of 14 CGCM and statistical model

(Wu et al. 2009 JGR)

Focus

- Diagnostic analysis based on rain-gauge observations
- Analysis based on satellite data
- Discussion of the mechanism
- Regional modeling

《夜雨寄北》

君问归期未有期，

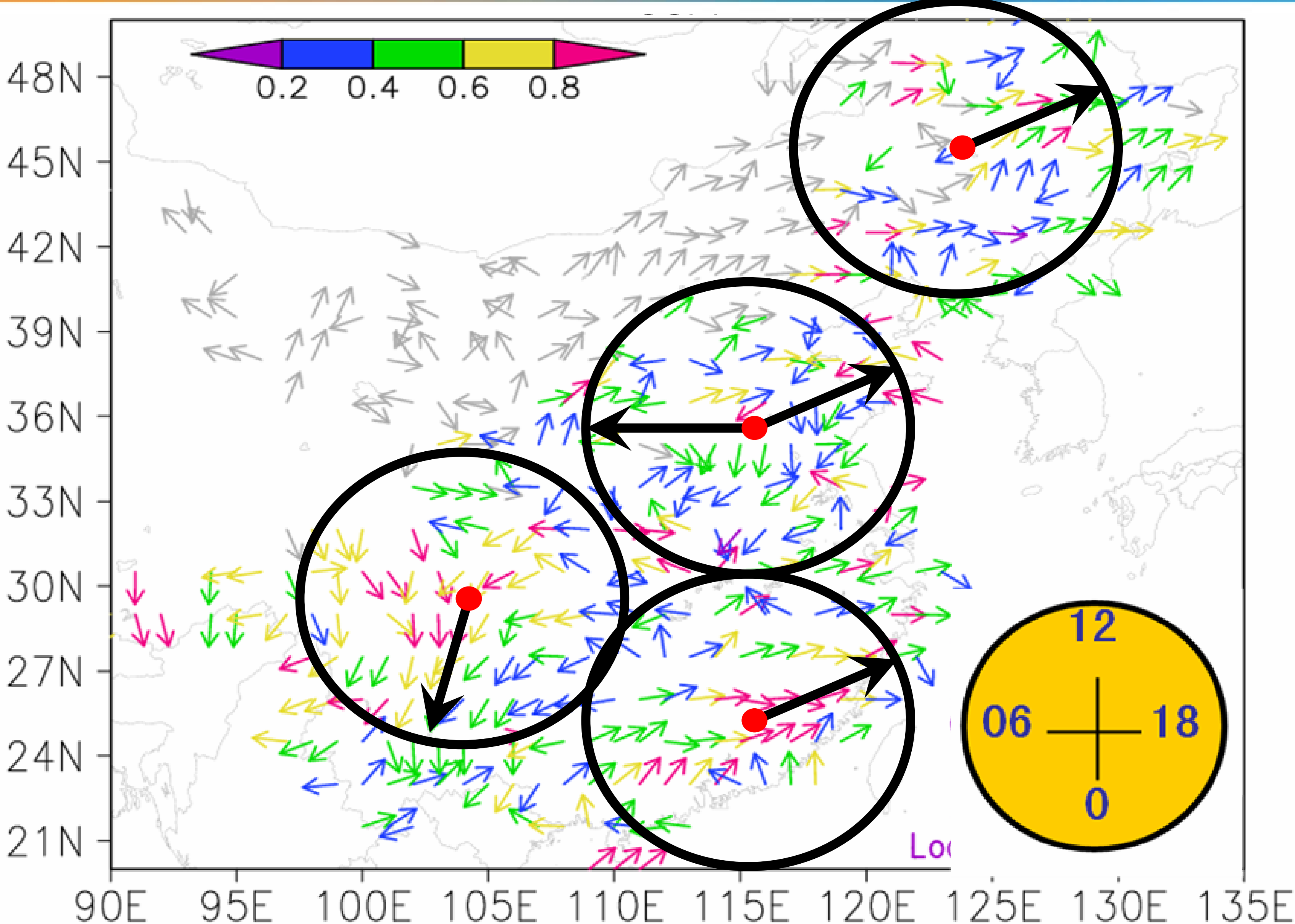
巴山夜雨涨秋池。

何当共剪西窗烛，

却话巴山夜雨时。

——李商隐(813—858)

Diurnal Cycle of JJA precipitation



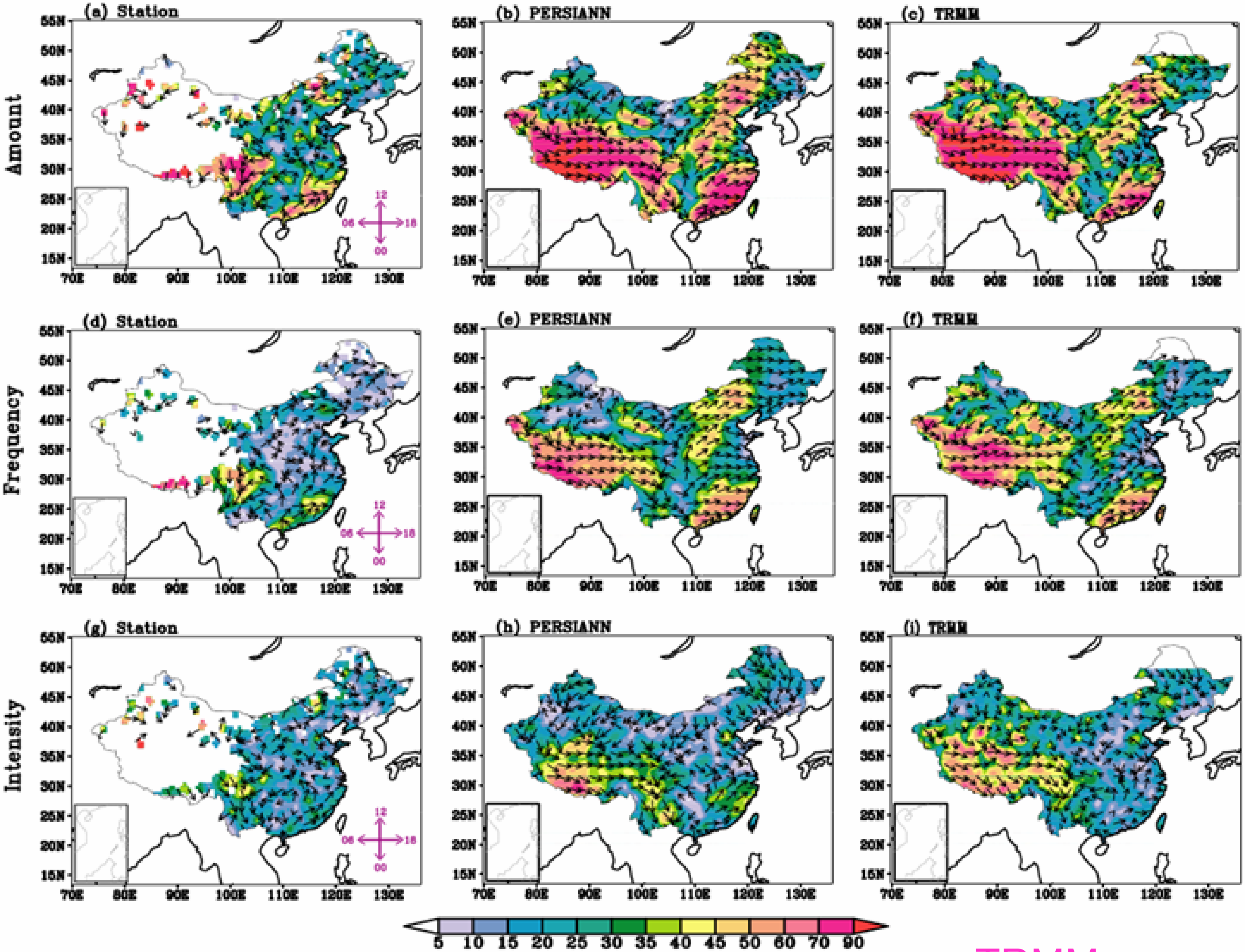
(Yu et al, 2007, GRL)

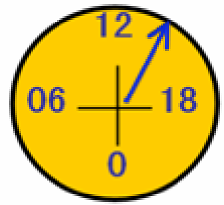
Spatial distributions of the amplitude (colors) and phase (arrows, LST) of the diurnal (24h, S1) harmonics of 2000-2004 mean JJA precipitation

Amount

Frequency

Intensity

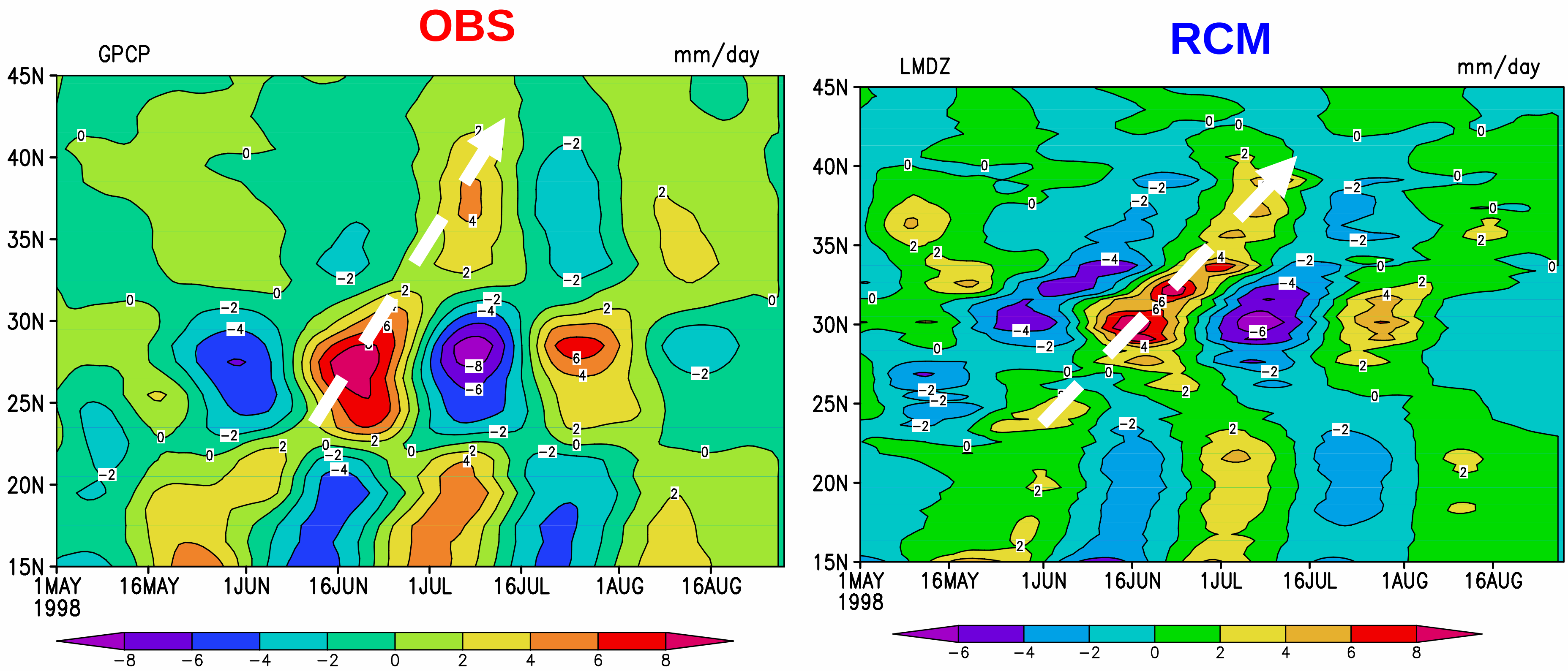




Rain-gauge PERSIANN TRMM

(Zhou et al. 2008b J. Climate)

Northward Propagation of ISO and Flooding along the YZR Valley



30-60 days band-pass filtered rainfall along 105~122.5°E of 1998

(Sun D. 2010)

Two Review Papers

Zhou, T., D. Gong, J. Li, B. Li, 2009: Detecting and understanding the multi-decadal variability of the East Asian Summer Monsoon – Recent progress and state of affairs. ***Meteorologische Zeitschrift*, 18** (4), 455-467

Zhou T., H. Hsu, J. Matsumoto, 2010: Summer Monsoons in East Asia, Indochina and the Western North Pacific, *Report of WMO 4th International Workshop on Monsoons* (IWM-IV), ***WMO Report Series***, in Press

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New Projects

- Ministry of Science & Technology (MOST)
- Chinese Academy of Sciences (CAS)
- National Natural Science Foundation of China (NSFC)
- China Meteorological Administration (CMA)

MOST funding for global change, among 20 approved projects

1. Development of High Resolution Climate System Model

   PI: R. YU

   Period: 2010-2015; Budget: ~ 4.5 million USD

2. Development of Biogeochemistry model

   PI: M. ZHANG

   Period: 2010-2015; Budget: ~ 4.5 million USD

3. Attribution and Projection of Climate Change based on the Multi-Model Ensemble Simulations from CMIP5

   PI: W. Dong

   Period: 2010-2015; Budget: ~ 4.5 million USD

4. Air-Land-Sea Interactions in Asia and their role in Global Change

   PI: J. Li

   Period: 2010-2015; Budget: ~ 4.5 million USD

5. Reconstruction of the past 2000-yrs climate of China

   PI: Q. Ge

   Period: 2010-2015; Budget: ~ 4.5 million USD

CAS funding for global change, among 15 approved projects

1. Ocean-Atmosphere-Land Interaction and EASM Variability

   PI: H. Wang & Y. Hou

   Period: 2010-2011; Budget: ~ 2.5 million USD

2. Data Uncertainty and 20th century climate change over China

   PI: Yang & Lu

   Period: 2010-2015; Budget: ~ 5 million USD

3. Improvement of uncertainties in CAS climate system model

   PI: Lin & Zhou

   Period: 2010-2015; Budget: ~ 5 million USD

4. Aerosol emission in China and its climate impacts

   PI: Cao & Liao

   Period: 2010-2015; Budget: ~ 5 million USD

5. Reconstruction of climate records of China for the past 2000-yrs

   PI: Ge

   Period: 2010-2015; Budget: ~ 5 million USD

Projects from NSFC

Climate of China during the past millennium

PI: X. Zhou (CMA)

Period: 2009-2012; Budget: ~ 2.5 million USD

- **Sub-project-1: Reconstruction based on tree ring (PI: Y. Liu)**
- **Sub-project-2: Numerical simulation (PI: T. Zhou)**
- **Sub-project-3: Diagnosis and inter-comparison of proxy data (PI: P. Zhao)**

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Suggested interactions with AAMP

- Detection and attribution of interdecadal EA monsoon variability
- Predictability of interdecadal monsoon variability (CMIP5 decadal prediction Exps)
- Future change of AAM in RCP Exps. (AR5)
- Monsoon variability in last millennial simulation

LASG

THANKS

www.lasg.ac.cn/staff/ztj/index_e.htm

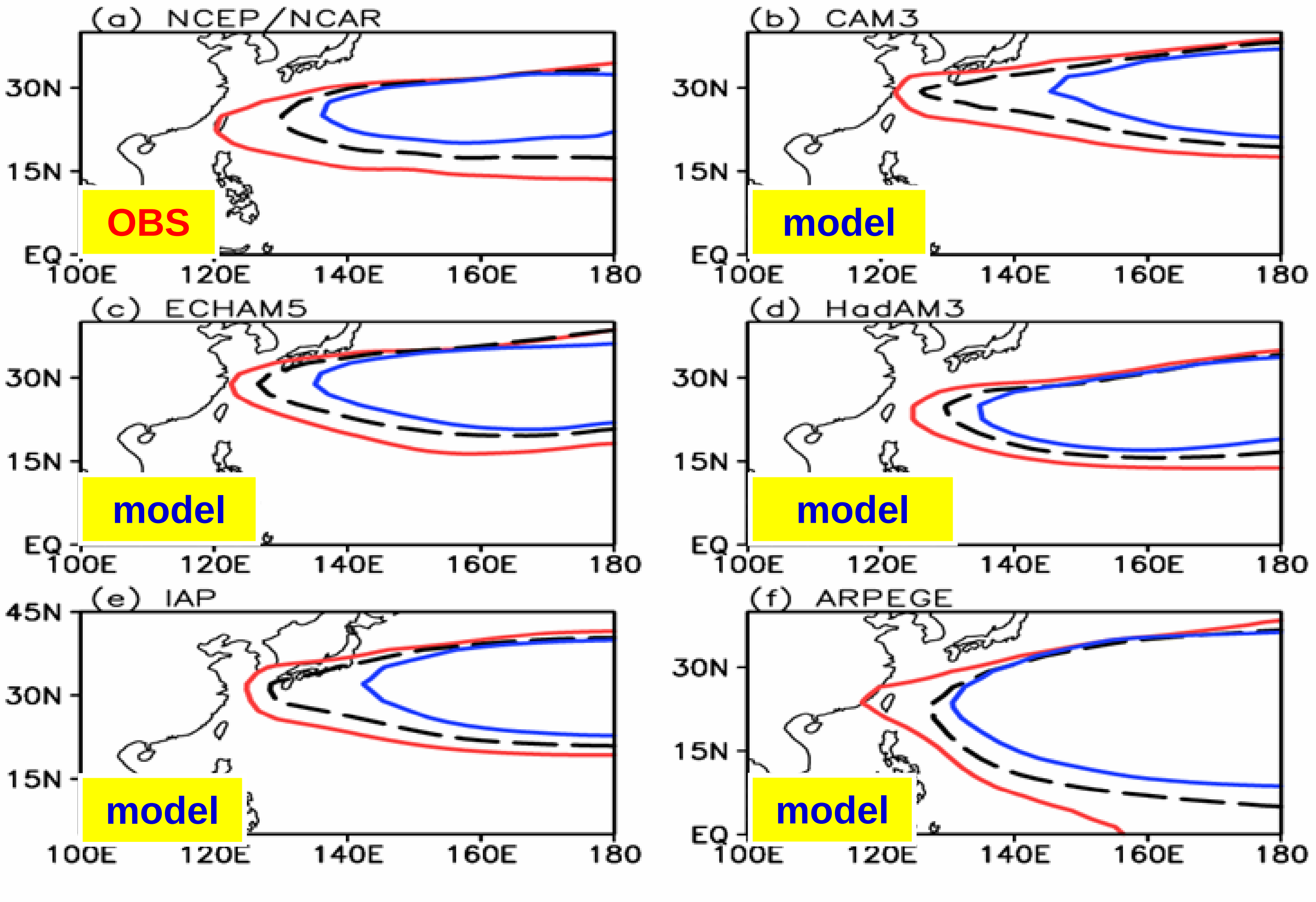
Prominent Features

- S. China Flood N. China drought (Hu, 1997; Wang, 2001)
- Westward extension of WPSH (Hu, 1997; Gong and Ho, 2002)
- Zonal expansion of South Asian High (Zhang et al., 2000)
- Tropospheric cooling over E. Asia (Yu et al. 2004; Yu and Zhou, 2007)
- East Asian westerly jet (Yu et al. 2004; Schiemann et al., 2009)
- Spring rainfall change (Xin et al. 2006; Cai et al. 2009)
- Land-Sea thermal contrast change (Ding et al. 2007)
- …. …

(Zhou et al. 2009, *Meteorologische Zeitschrift* for a Review)

Westward Extension of WPSH due to IWP warming

Warm, Cold, and Normal SST



(Zhou et al. 2009 J Climate)