CAS IAP

Key Lab of Regional Climate-Environment for East Asia

START

Regional Center for East Asia

Gensuo Jia

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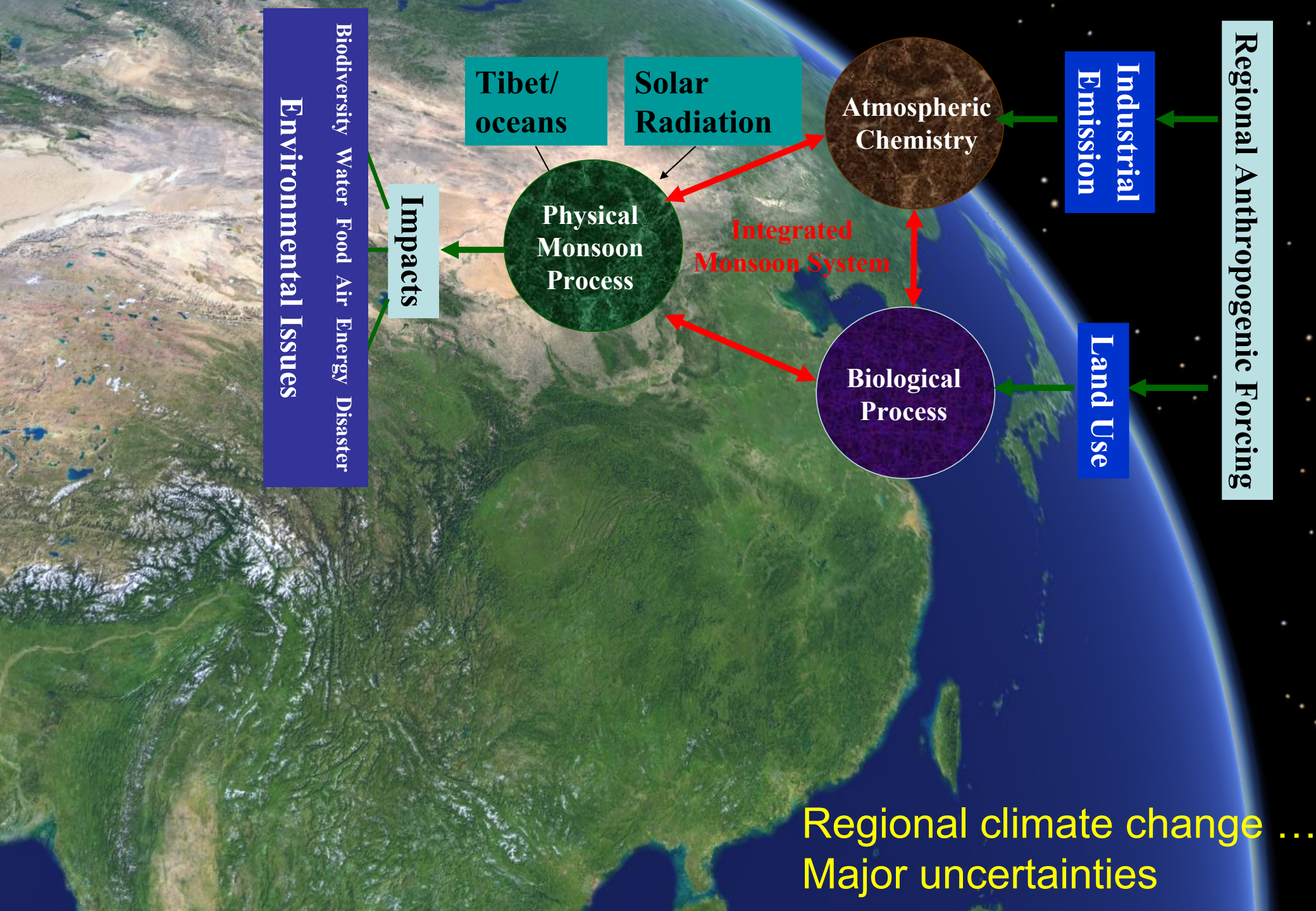

Regional Anthropogenic Forcing
Industrial Emission
Land Use
Atmospheric Chemistry
Biological Process
Integrated Monsoon System
Tibet/ oceans
Solar Radiation
Physical Monsoon Process
Impacts
Environmental Issues
Biodiversity Water Food Air Energy Disaster
Regional climate change …
Major uncertainties

Characteristics of East Asia

1. **Monsoon climate** with Tibetan Plateau
2. **Dense population:** intensified human activities
3. **Long history:** old agriculture, young industry
4. **Rapid economic development**

GHGs, aerosol, landuse …

TEA: Missions and Scope

- To understand the processes and mechanisms of the monsoon environment system in East Asia;
- To develop the theories and tools for the predicting regional environmental changes in next 10-30 years;
- To provide science support on orderly human activities for sustainable development in East Asia, especially in China.

Research Foci

- Integrated studies on the monsoon environmental system of East Asia under global change;
- Comprehensive field experiments and synthesis on the effects of orderly human activities to life support environment;
- Investigate abrupt changes and extremes of the regional Earth system and climate.

Brief History of TEA

1978： IAP Lab of Climate Dynamics

1994： CAS Center of Global Change Study for East Asia

1995： START Regional Center for East Asia (TEA)

2002： CAS Key Lab of Climate-Environment for East Asia

2010： CAS and IAP preferential support

Prof. Ye Duzheng

Currently 42 employees, incl. 2 academicians and 12 senior professors in climate, geosciences, and ecology.

37 graduate students

Research Facilities

Observation sites and network

- Tongyu Field Station (Grassland & Cropland)
- Coordinated Observation and Synthesis Network (COSAS)

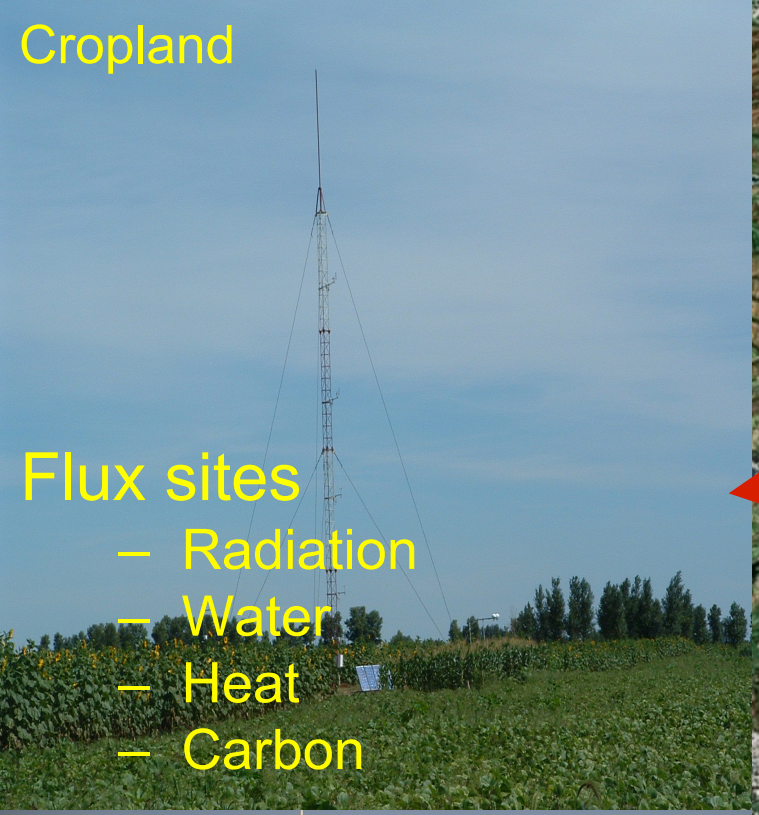
Regional data system

- In-situ data
- Satellite data

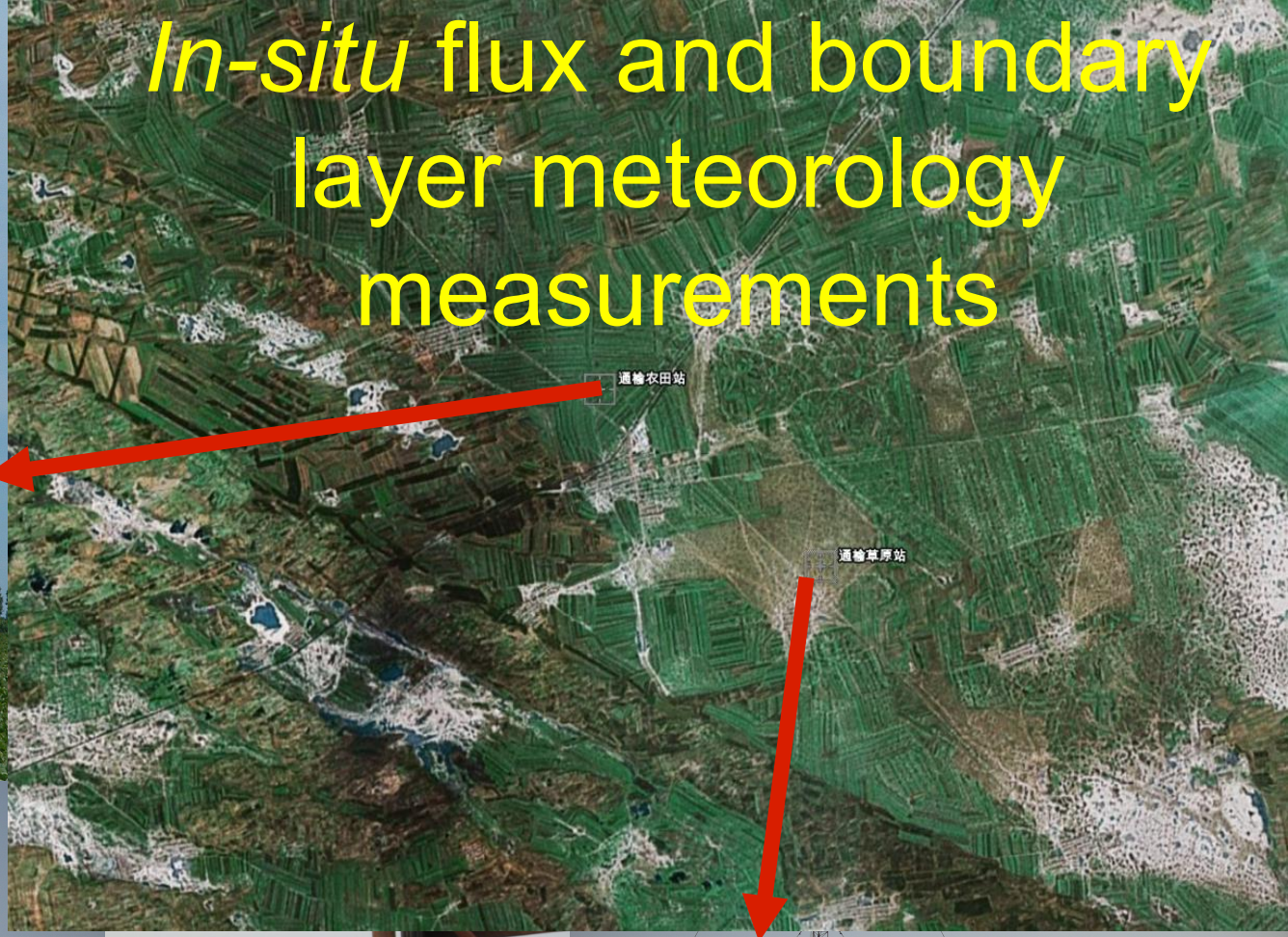
Assimilation and modeling

- RIEMS: Regional integrated environmental model system
- RMIP: Regional multi-model inter-comparison project

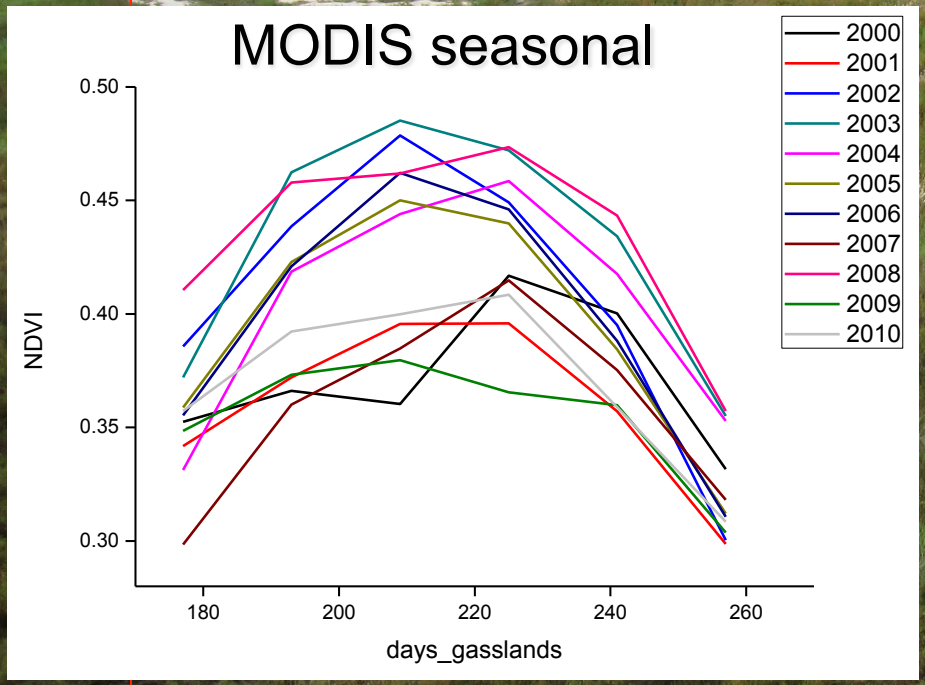
In-situ flux and boundary layer meteorology measurements

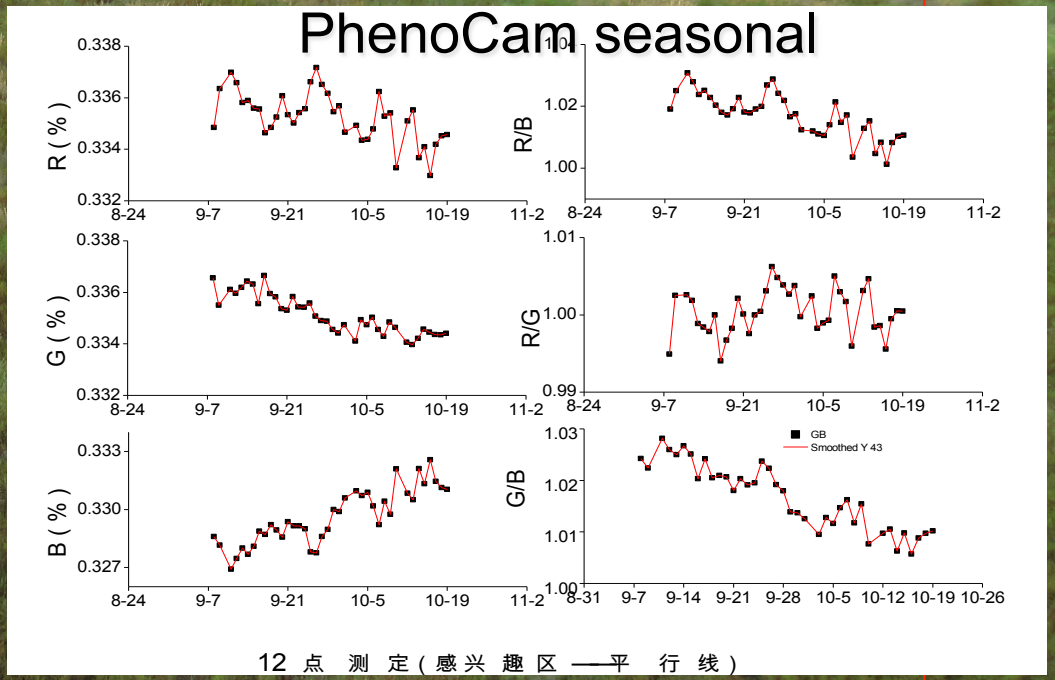


Flux sites
- Radiation
- Water
- Heat
- Carbon



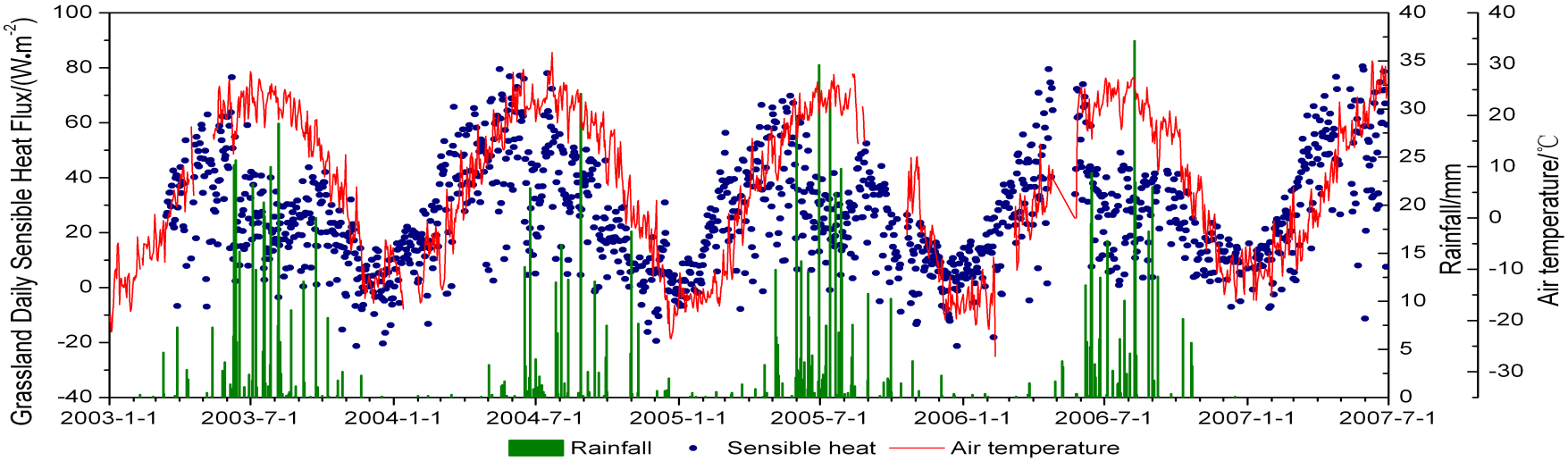
Inter-calibration: field vs. satellite



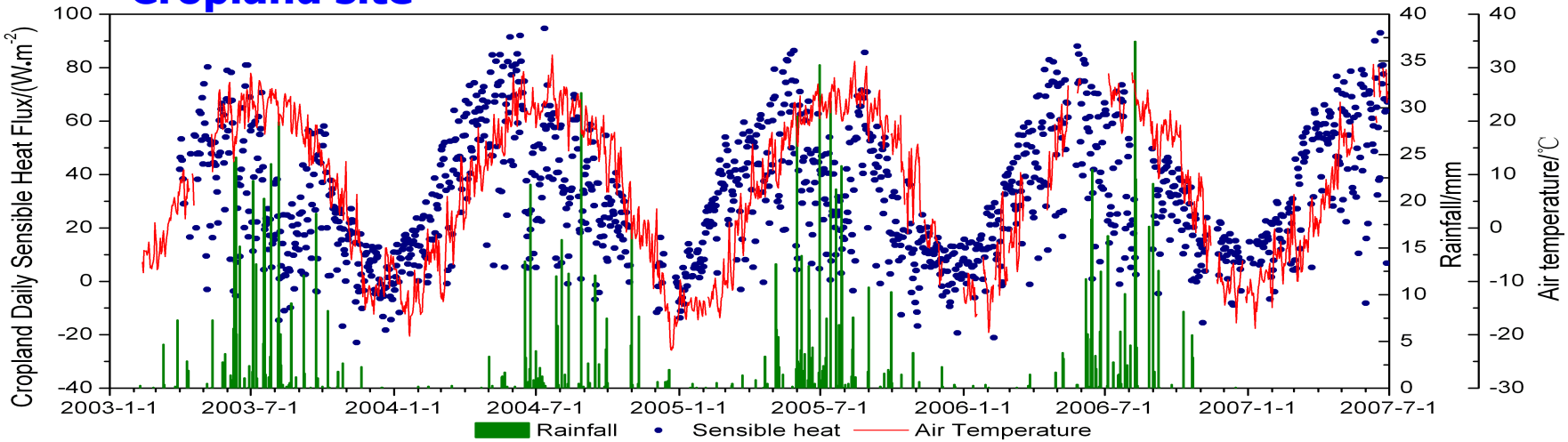


TONGYU Longterm Data Records 2002-

Grassland site



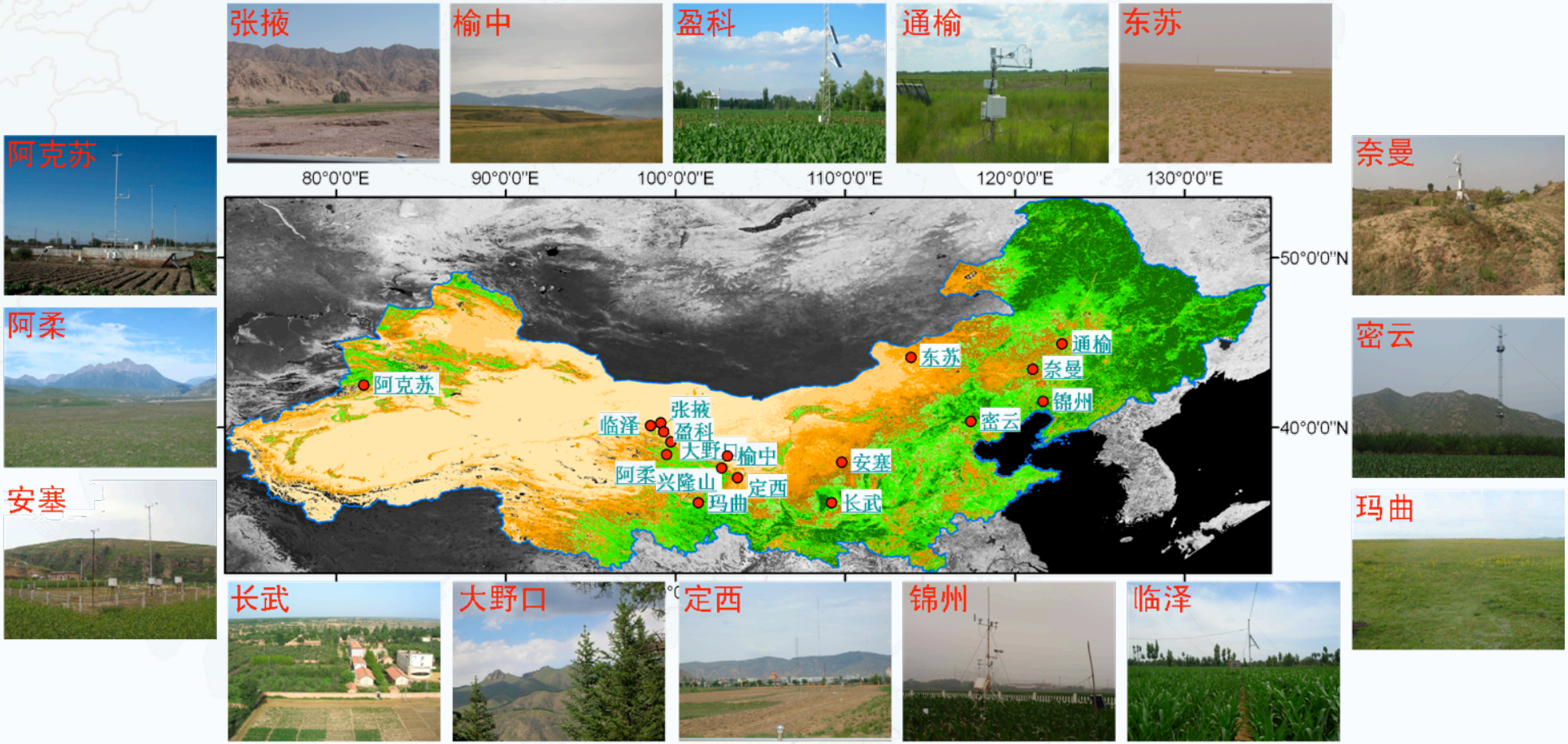
Cropland site



Coordinated observation and synthesis

23 participant sites across biomes and landuse, 2008-2012

Observation of land-atmospheric energy, water, and CO2 exchanges



Coordinated observations

Pilot experiment of coordinated observation in arid/semi-arid China, 2008-2012, a science driven, volunteer, mutual benefit project initiated in 2007 by CAS IAP.

- Observation: energy, water, and CO2 exchanges.
- Instruments calibration and CEOP protocol.
- Time windows: May-October, 2008-2012.
- 23 participant sites in arid/semiarid China.
- Quality assurance and data compatibility (accuracy and representative).
- Synthesis, satellite data integration, and scaling-up

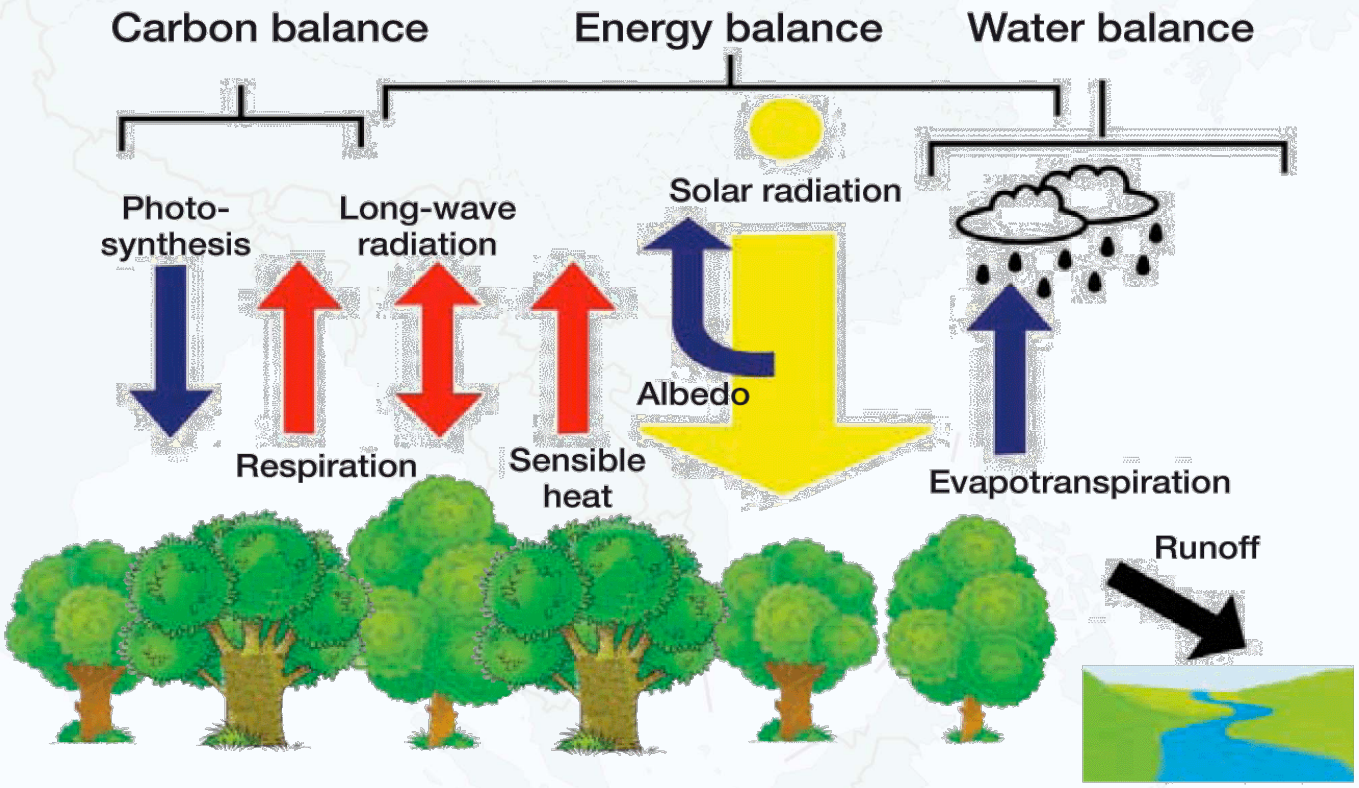
Vegetation / landcover change ←→

Carbon budget: Photosynthesis - Respiration

Energy balance: ET, Latent / sensible heat (LW), Albedo (SW)

Water balance: Inception, ET, runoff, Cloud / water vapor

←→ Local and Regional Climate

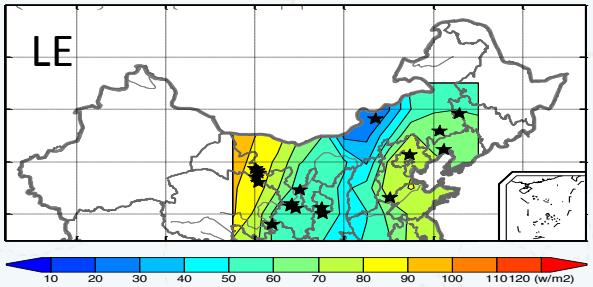


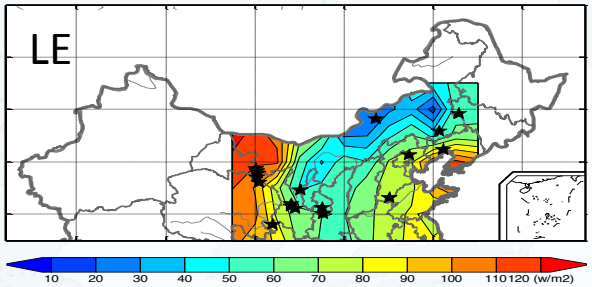
Chapin et al, 2009

Spatial Heterogeneity of Surface Heat Flux based on Coordinated Data（August 2008-2009）

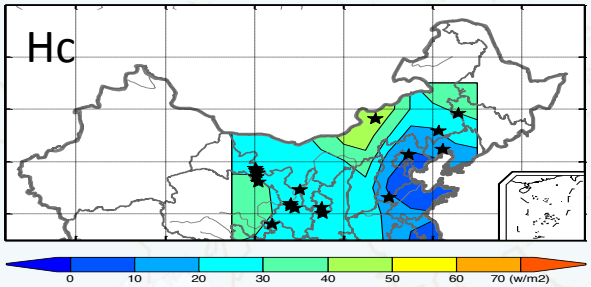
2008 2009

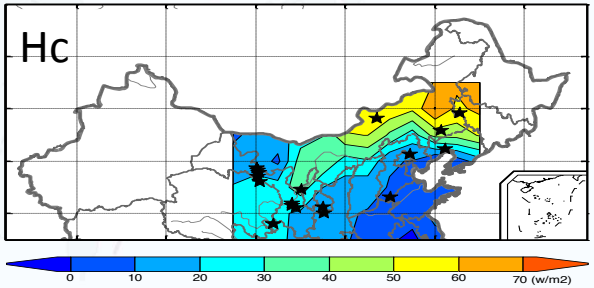
Latent



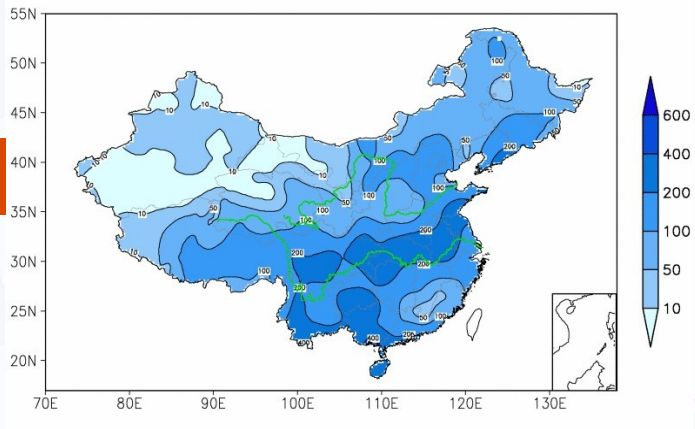


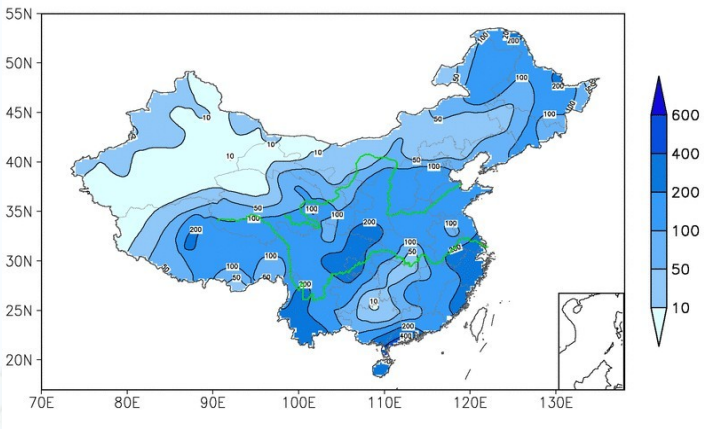
Sensible



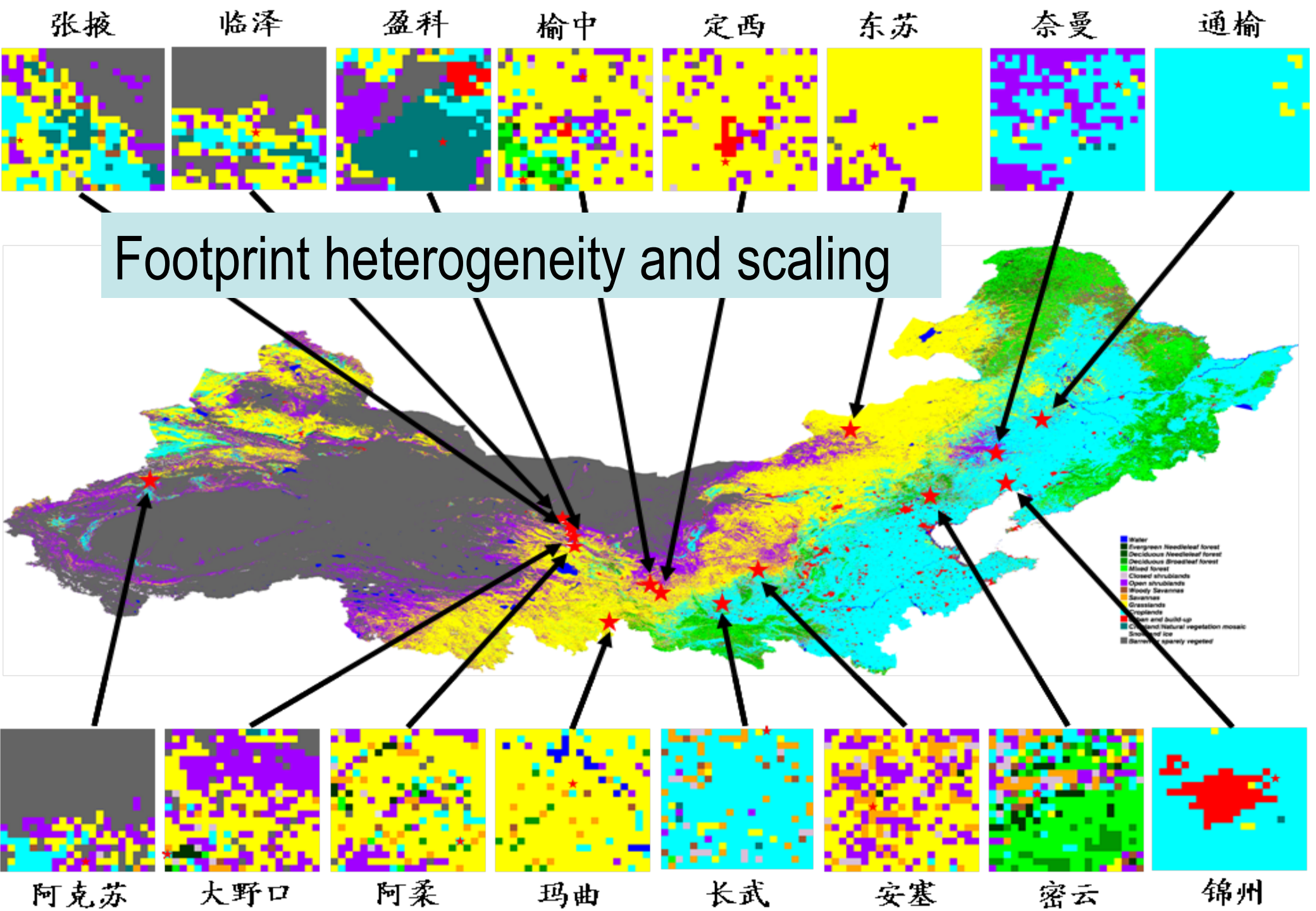


Precipitation





Footprint heterogeneity and scaling



Satellite data processed, 2008-2011

	Land cover	LST	Albedo	GPP	LAI	Soil moisture	Aerosol
Aksu	√	√	√	×	√	√	×
Naiman	√	√	√	√	√	√	×
Arou	√	√	√	√	√	√	×
Dayekou	√	√	√	√	√	√	×
Yinke	√	√	√	√	√	√	×
Linze	√	√	√	√	√	√	×
Maqu	√	√	√	√	√	√	×
Yuzhong	√	√	√	√	√	√	×
Xinglong	√	√	√	√	√	√	×
Changwu	√	√	√	√	√	√	×
Ansai	√	√	√	√	√	√	×
Zhangye	√	√	√	√	√	√	×
Dingxi	√	√	√	√	√	√	×
Tongyu grass	√	√	√	√	√	√	×
Tongyu crop	√	√	√	√	√	√	×
Dongsu	√	√	√	√	√	√	×
Jinzhou	√	√	√	√	√	√	×
Miyun	√	√	√	√	√	×	×

Accurate DGPS location of sites

Window: 3x3 pixels

Terra/MODIS, Envisat/MERIS, MTSAT

Daily and weekly time series

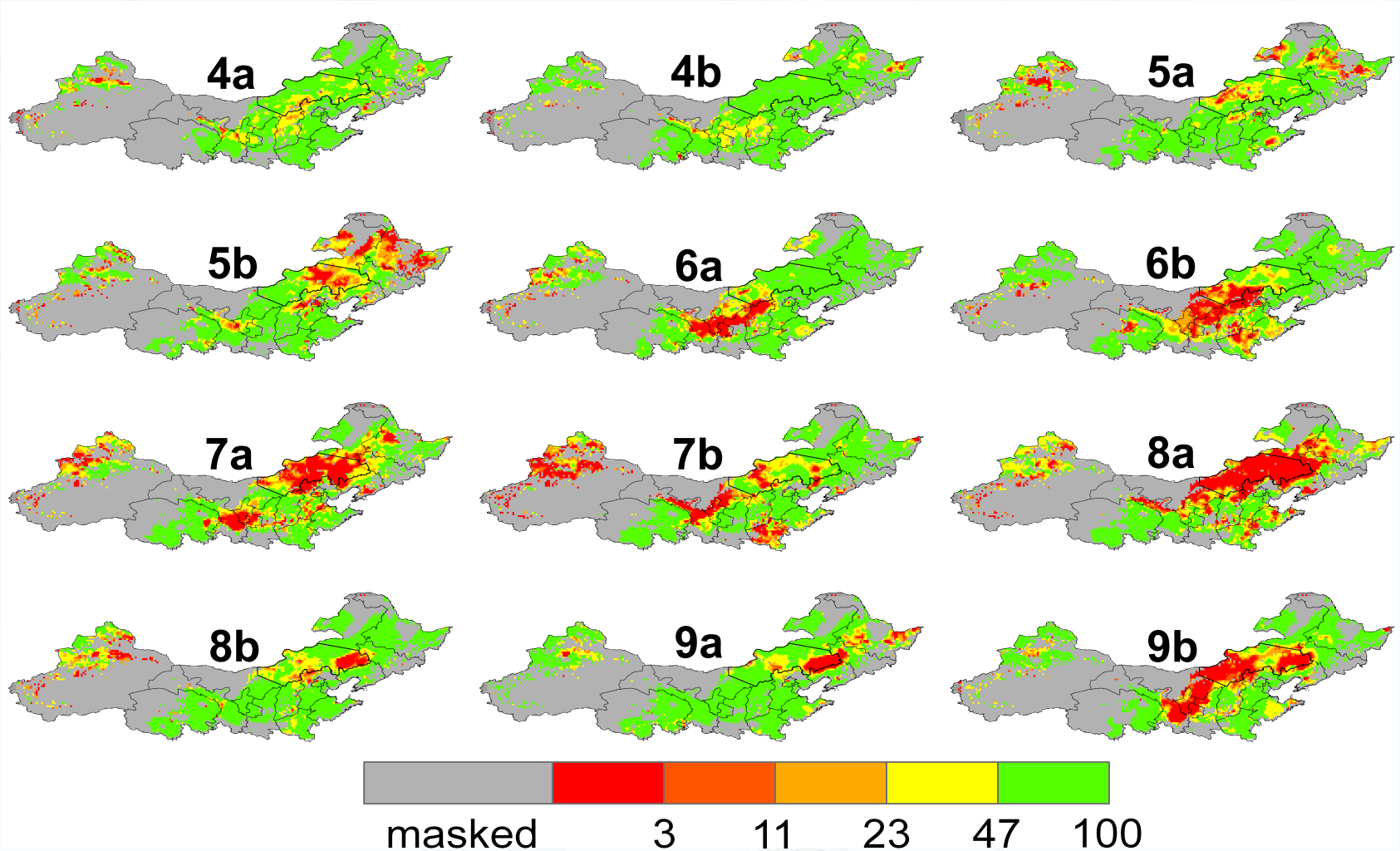
Data quality control and validation

Comparison with site measurements

Detecting 2009 drought in northern China

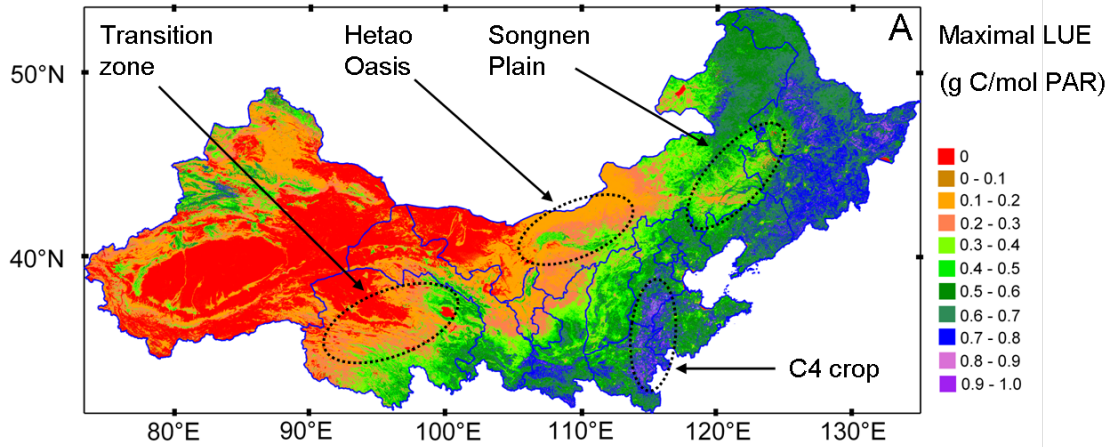
Data：integrated Aqua/AMSR-E and field soil moisture, daily

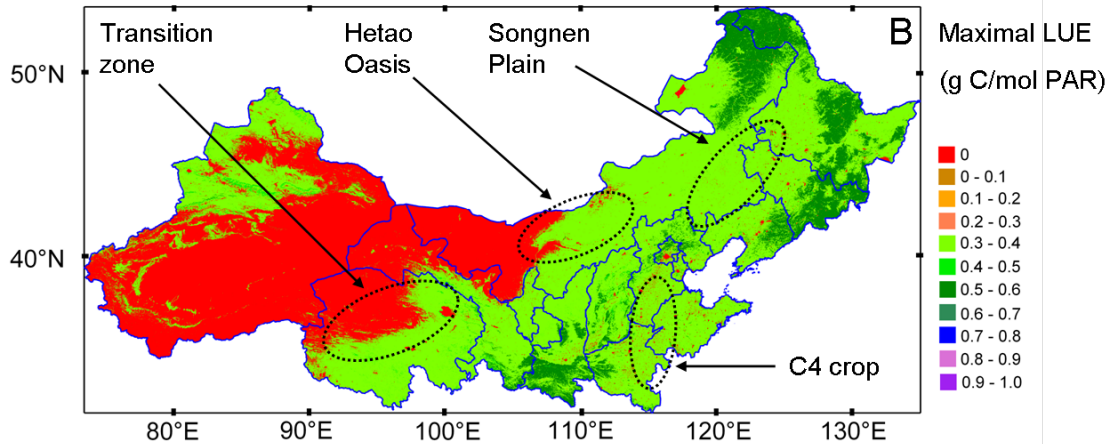
Analysis: validation and improved algorism， 2009 vs. 2003-2011



GPP modeling

Based on satellite and in-situ data

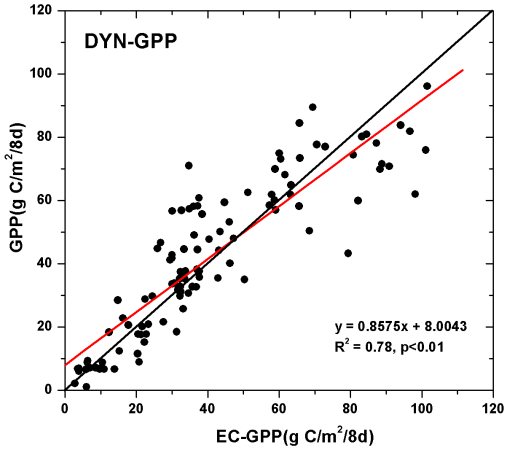


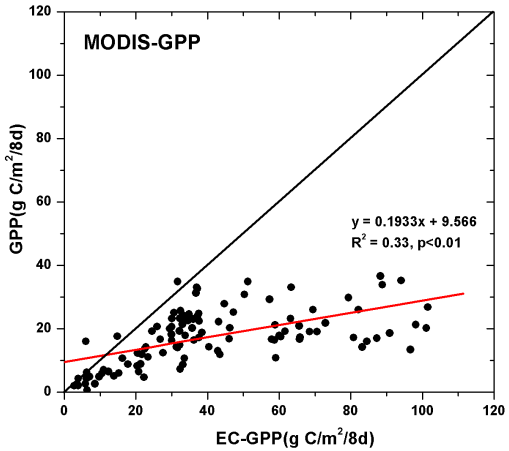


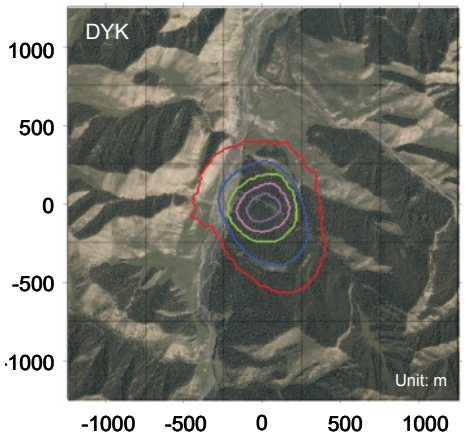
2008 GPP in northern China:
518.4 gC/m2

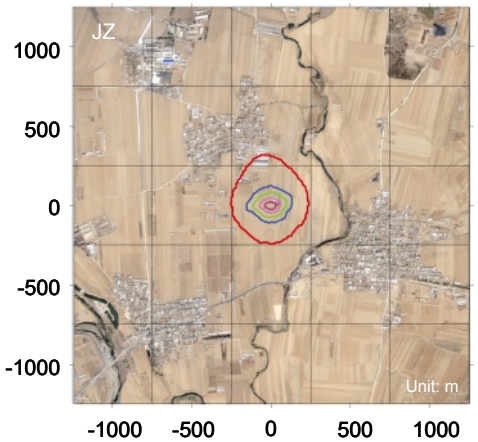
47% greater than MOD17A2

More details

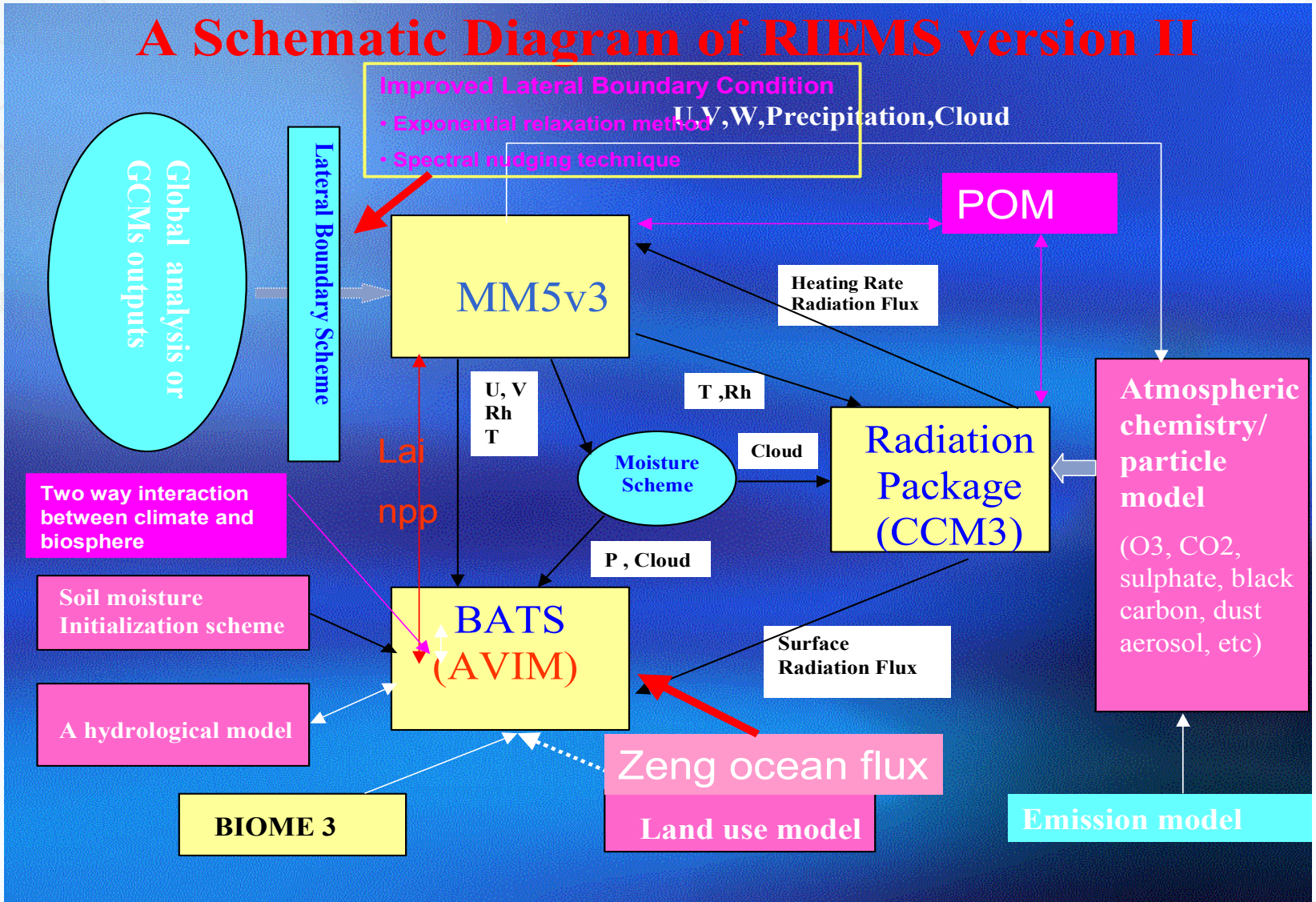






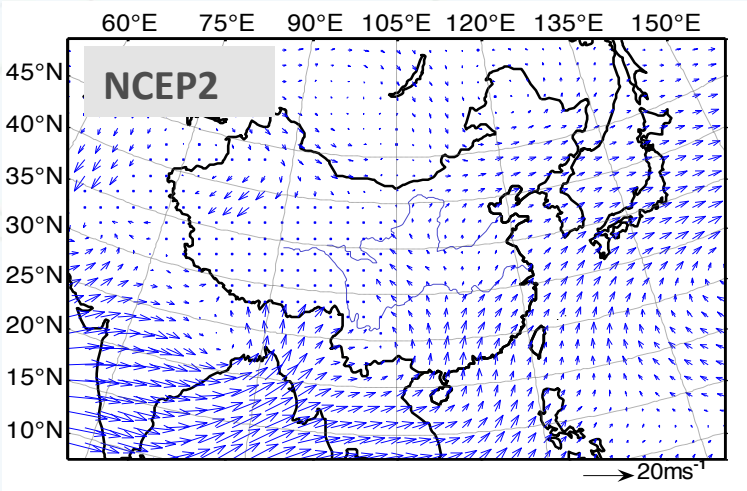


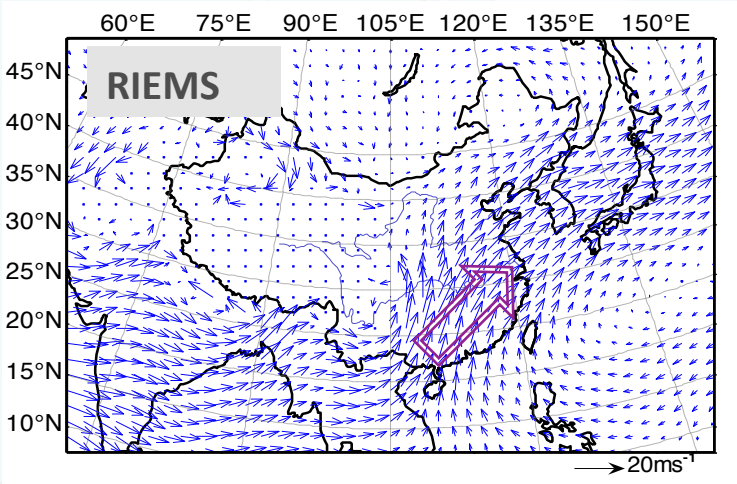
Regional Integrated Environment Modeling System (RIEMS)



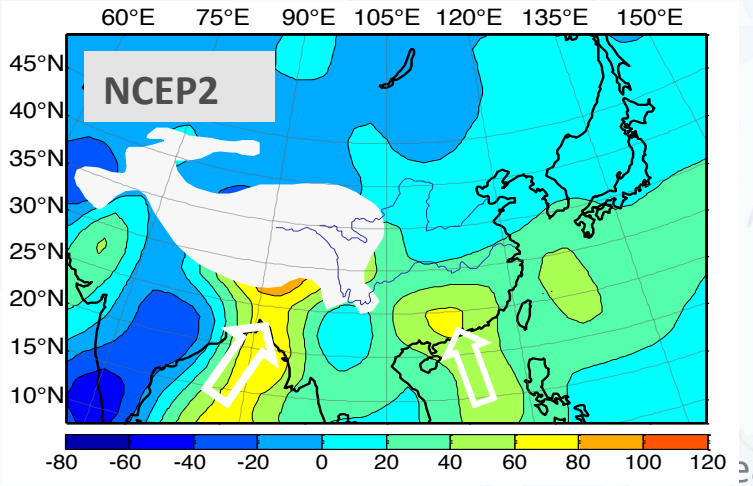
Simulation of East Asia monsoon

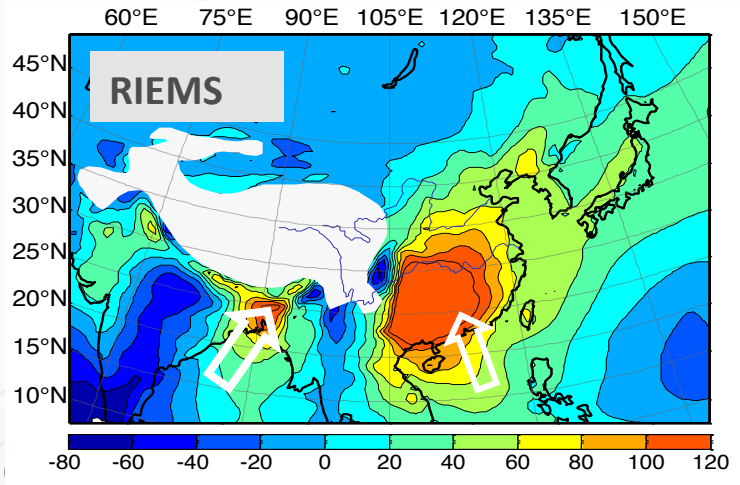
Summer Monsoon Circulation: Wind vector at 850hPa



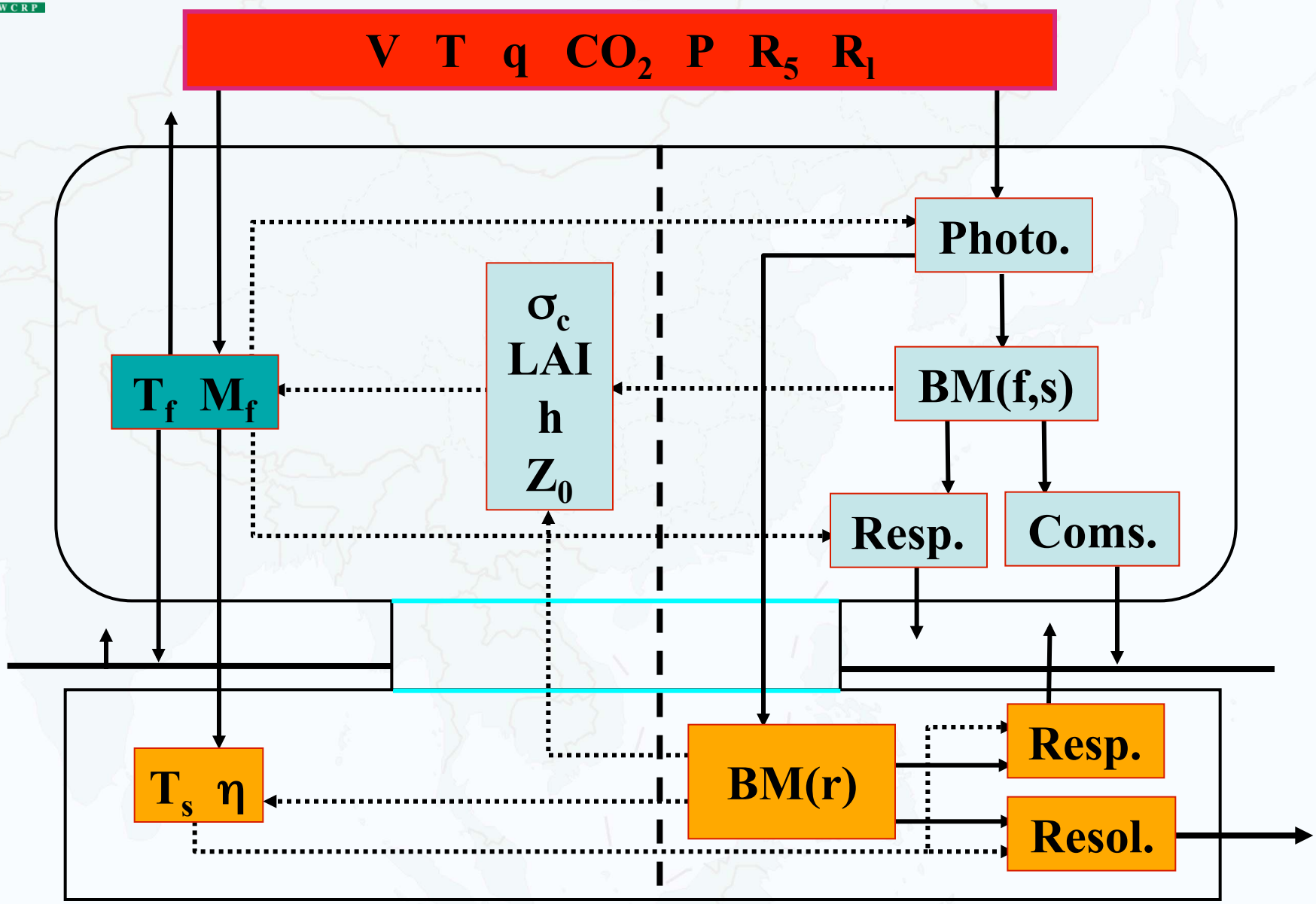


10-year Averaged Summer Moisture Transport at 850 hPa





ATMOSPHERE-VEGETATION INTERACTION MODEL (AVIM)



Regional Multi-model Comparison RMIP

实验设计

Participant models for RMIP I (2003-2005)

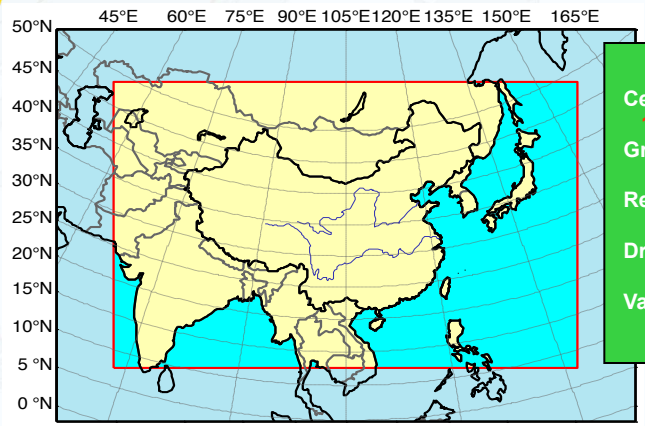
Model	RIEMS	DARLAM	CCAM	JSM_BAIM	RegCM
Group leader	C. Fu	J. McGregor	J. McGregor	Y. Sato	J. Kim
Country	China	Australia	Australia	Japan	South Korea

Model	RegCM2a	RegCM2b	ALT. MM5/LSM	SNU RCM
Group leader	M. Suh	H. Kato	W. Gutowski	D. Lee
Country	South Korea	Japan	United States	South Korea

Participant models for RMIP II (2009-2011)

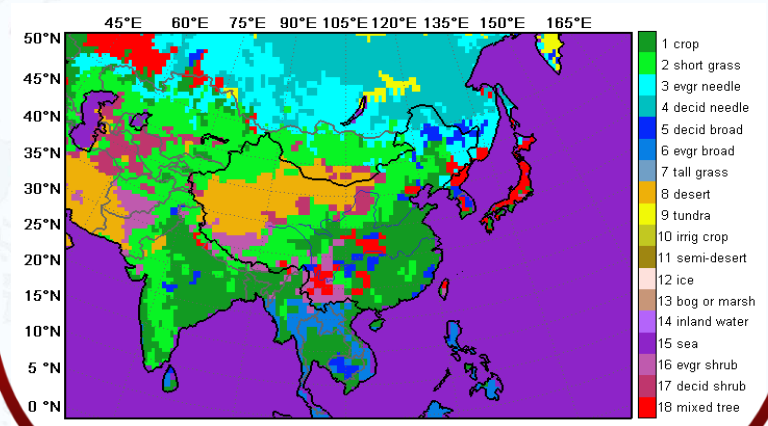
RIEMS	RegCM3	NJU MM5	SNU RCM	MRI (JSM_BAIM)	CSIRO CCAM
Congbin Fu	Hisashi Kato	Bingkai Su	D. Lee	Yasuo Sato	J. McGregor
China	*Japan*	*China*	*Korea*	*Japan*	*Australia*

Domain: East Asia



Centered: 105E, 35N
Grid: 151×111
Resolution: 60km
Driven: NCEP2
Validation: in-situ, RS

Land cover



East Asia Regional Models Group Leader: Zong-Liang Yang

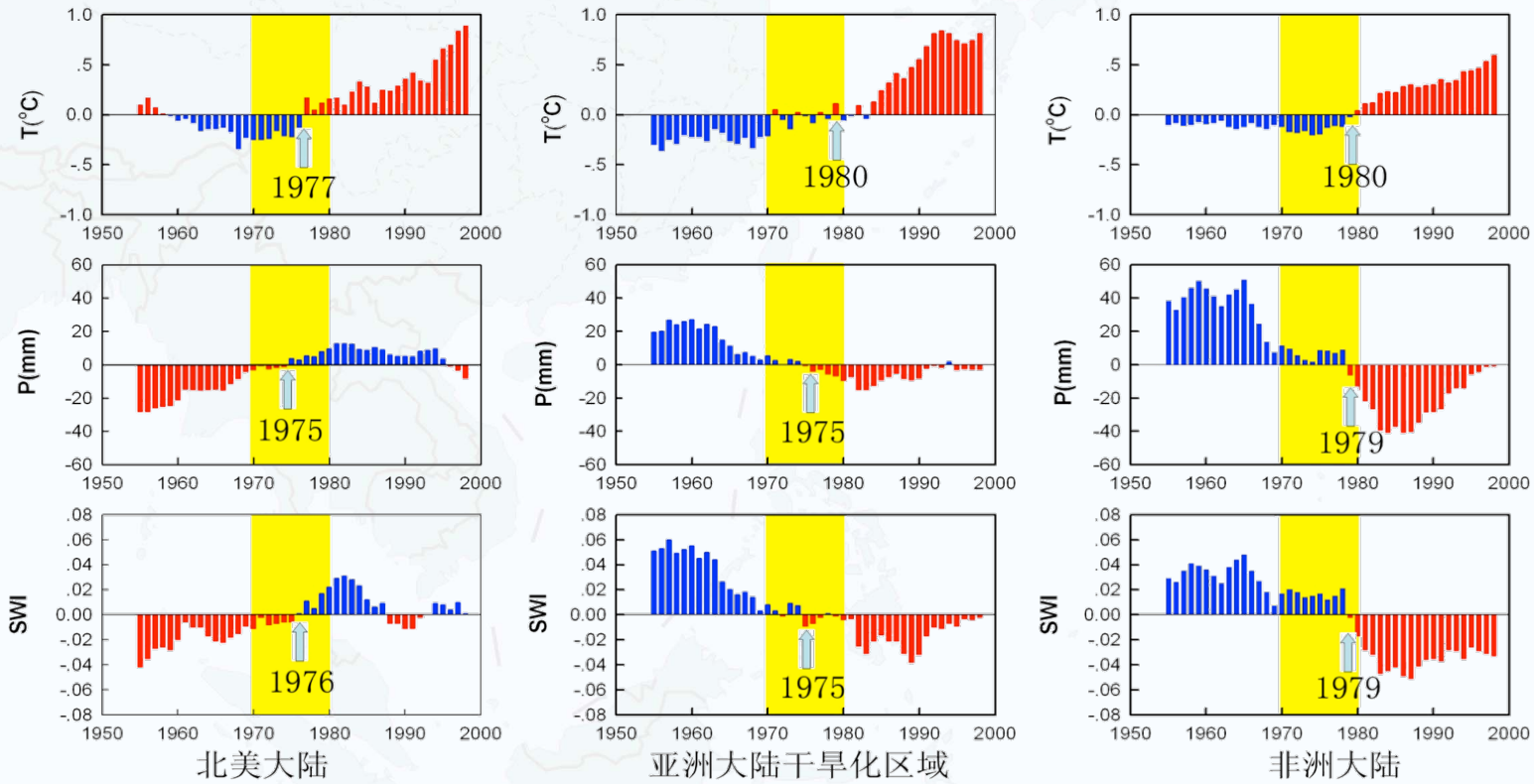
National Basic Research (973) sub-Projects

	Project	PI	Period
1	Patterns and Mechanisms of extreme climate in China	YAN Zhongwei	2009—2013
2	Mechanisms and methods for satellite observation of regional climate change	JIA Gensuo	2009—2013
3	Air pollutants and their climate forcing over mega-cities	ZHANG Renjian	2010—2014
4	Impacts of large-scale LUCC on energy and water flux in monsoon climate system	ZHAO Deming	2011—2015
5	Mechanisms of climate effects of regional LUCC cross scales	YAN Xiaodong	2011—2015
6	Decadal global droughts and dynamic mechanisms	MA Zhuguo	2012—2016
7	Contribution of human activities on decadal climate change over semiarid regions	ZHAO Tianbao	2012—2016
8	Impacts of differentiated response of Pacific and Indian Oceans to global warming on East Asia climate	HUANG Gang	2012—2016

TEA research grants 2009-2012: 87 million CNY

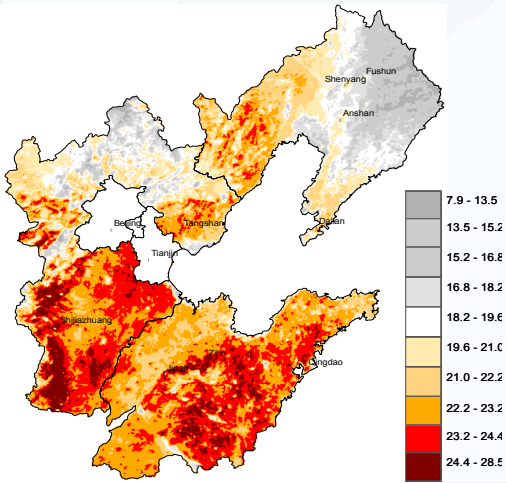
MOST Global Change Program: Decadal droughts and mechanisms over Asia-Africa drylands (2012CB956200), PI: MA Zhuguo, 2012-2016, 32,500,000 CNY

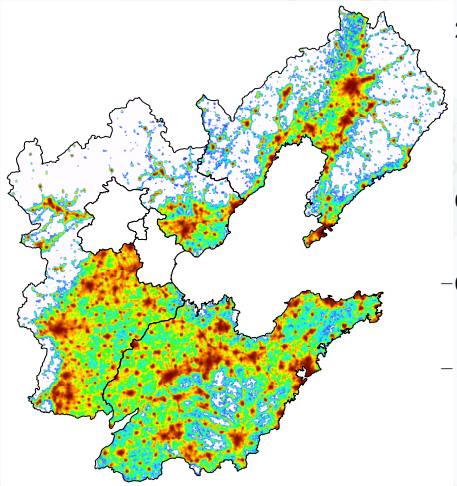
- Patterns, mechanisms, and tele-connections of drought over dryland;
- Contributions of land and ocean processes to drought
- Future drought in next 10-30 years

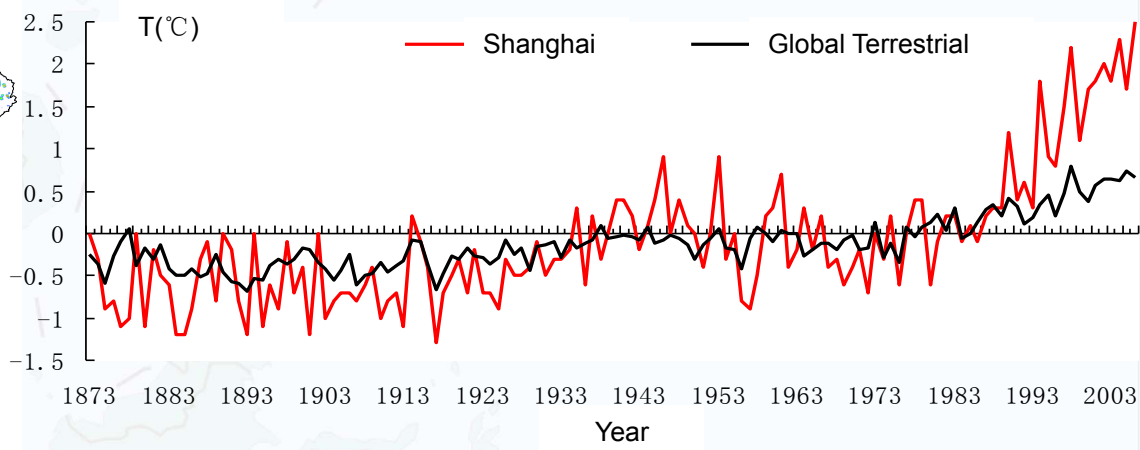


CAS Climate Change Science: Centennial warming and controls (XDA05090000), PI: YAN Zhongwei, 2011-2015, 35,000,000 CNY

- General trends and heterogeneity of warming over East Asia in past 100 years;
- Land use, e.g. urbanization in climate change
- Regional climate projection



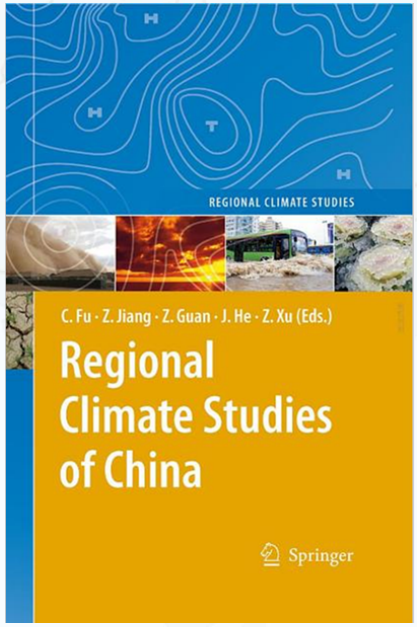




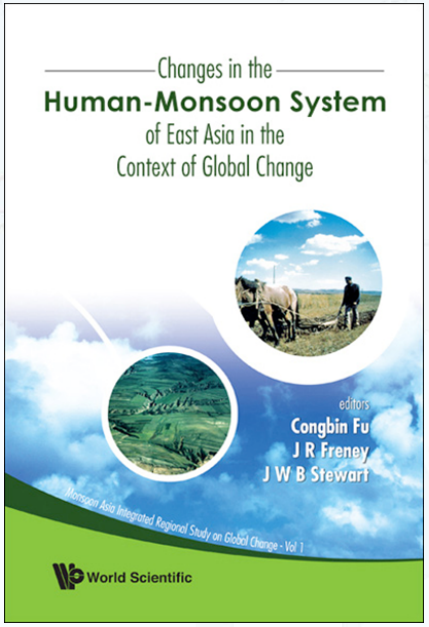
Regional Synthesis and Publications

- Over 50 papers published annually in international journals
- Synthesis reports:

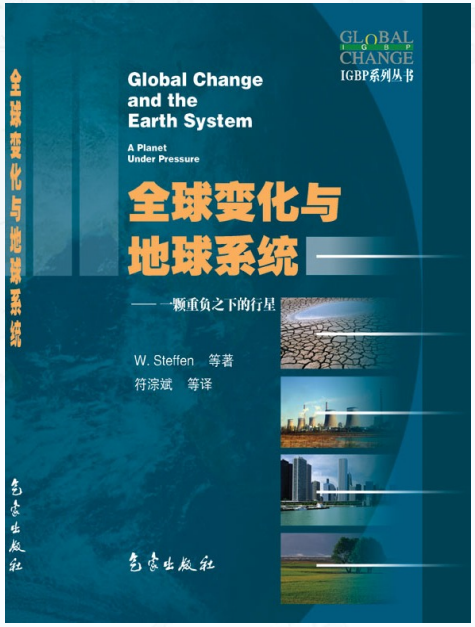
  Fu et al, 2008a; 2008b; 2009; Jia et al, 2011



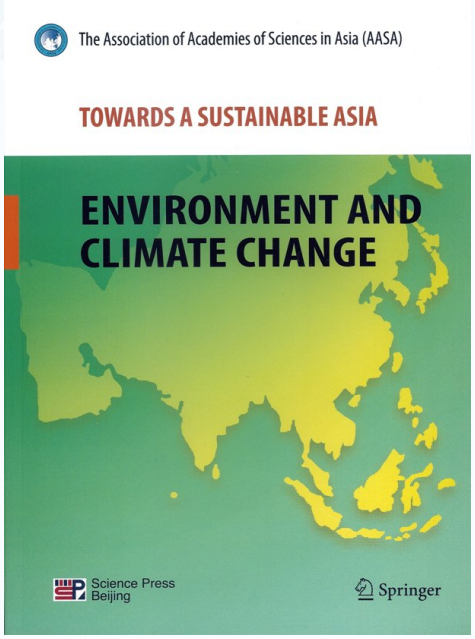
Springer 2008



World Scientific 2008



IGBP 2005, 2009



Springer 2011

CAS-START International Training on Regional Climate Change. October 7-24, 2012. Beijing

http://www.tea.ac.cn/training2012

Training scheme:

- Multi-platform observation
- Analysis and synthesis: dynamics, impacts, adaptation
- Regional land processes and climate modeling

Trainees: 25 Asian + 25 China. So far, 110 intl. applications from 17 countries, incl. India, Kyrgyz, Mongolia, Vietnam, Yemen, etc.

Funding: CAS $60,000 + TEA $30,000

Publication Highlight 2011-2012

Qian C, et al, 2011: On changing El Niño: A view from time-varying annual cycle, interannual variability and mean state. *J. Climate*, 24(24), 6486-6500

Zhao T., et al. 2012: Trends in Tropospheric Humidity from 1970 to 2008 over China from a Homogenized Radiosonde Dataset. *J. Climate* 25:13, 4549-4567

Feng, J., et al. 2012: Simulating the regional impacts of urbanization and anthropogenic heat release on climate across China, J. Climate. DOI: 10.1175/JCLI-D-11-00333.1

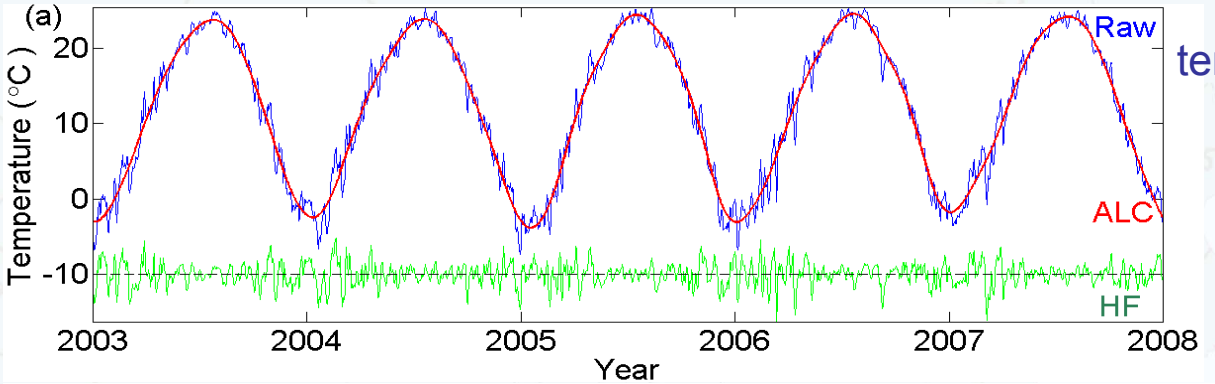
Li et al, 2011, Interdecadal modulation of El Nino amplitude during the past millennium, Nature Climate Change

……

Climatic changes in 24 particular timings in the seasonal cycle in China under global warming

Twenty-four Solar Terms

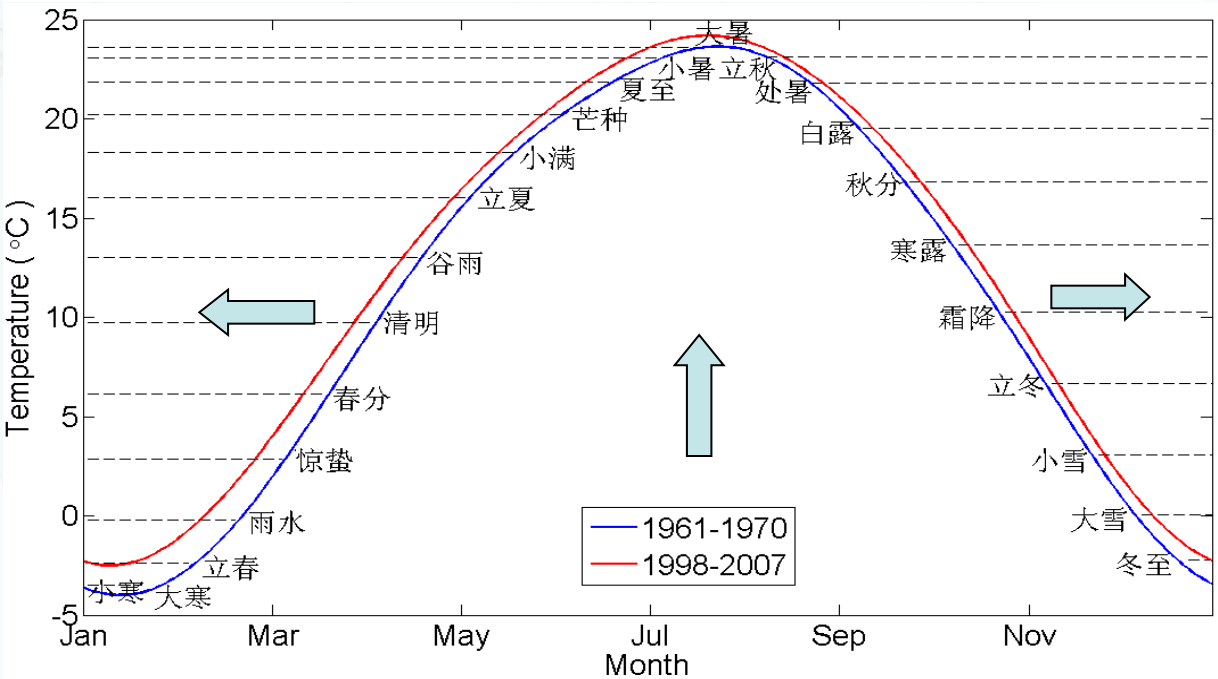
Method



A homogenized China mean temperature series over the last 50 years (Li and Yan, 2009)

smoothed by EEMD to filter out intra-annual high frequency fluctuation

Result



There has been a warming shift of the whole seasonal cycle under global warming, in terms of the mean situation over China in recent 50 years.

For 1961－2007：

①Timings during the warming period have advanced by 6~15d; those during the cooling period have delayed by 5~6d.

②Extremely hot days increased by 81％; extremely cold days decreased by 57％

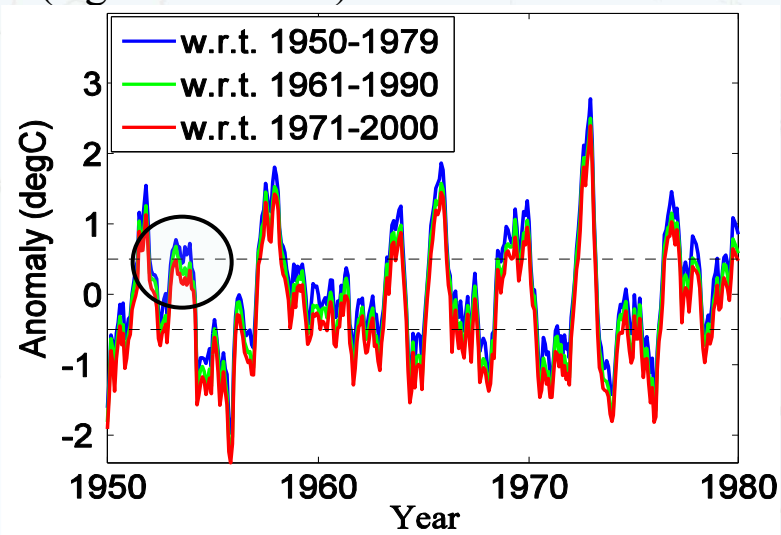
Thresholds: 1961－1990 mean

Qian et al. 2012 Chinese Sci. Bull.

A new strategy to classify El Niño/La Niña episodes under global warming

NOAA CPC

A minimum of 5 consecutive over-lapping seasons exceed a threshold of ± 0.5℃ for the Oceanic Niño Index, a 3 month running mean of ERSST.v3b SSTA in the Niño-3.4 region relative to a single fixed base period (e.g. 1971–2000).

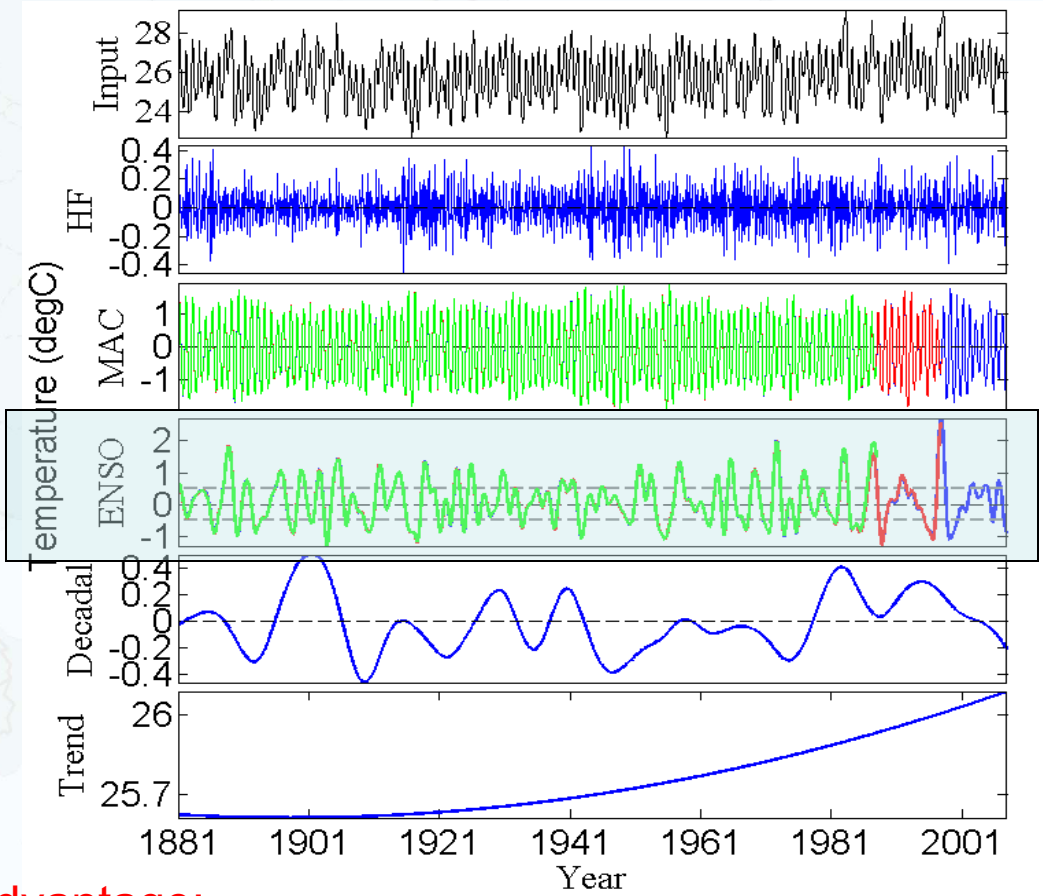


El Niño or not ?

Qian et al. 2011 J.Climate

An alternative one

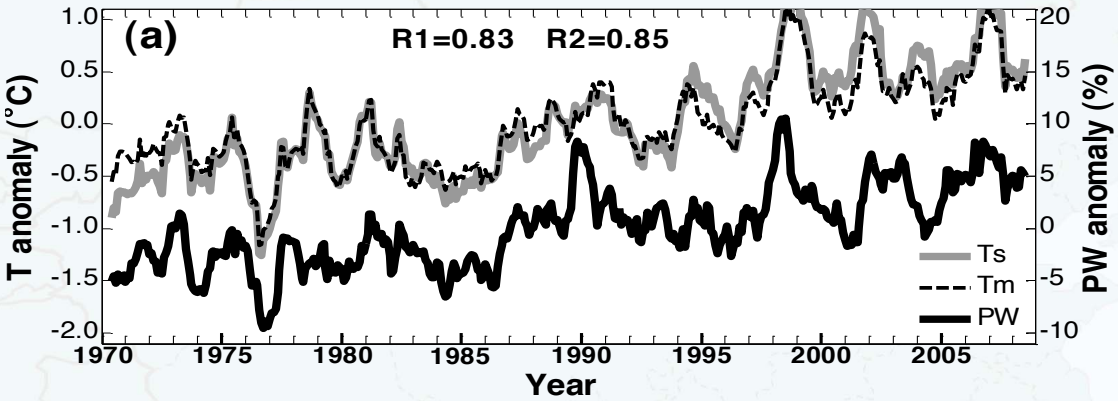
A minimum of 5 consecutive month exceed a threshold of ± 0.5℃ for the ENSO interannual only relative to a time-varying annual cycle and mean state.

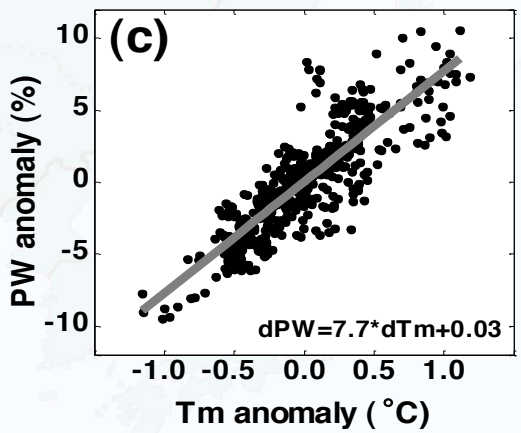


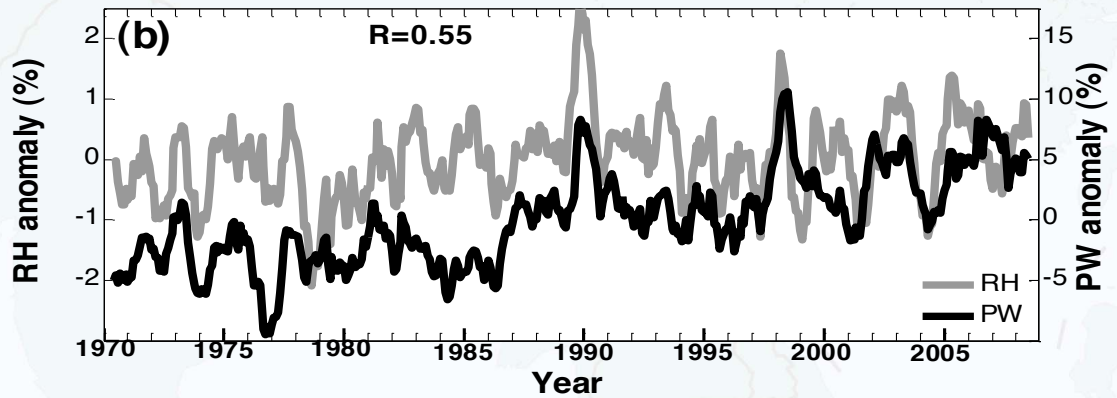
Advantage:

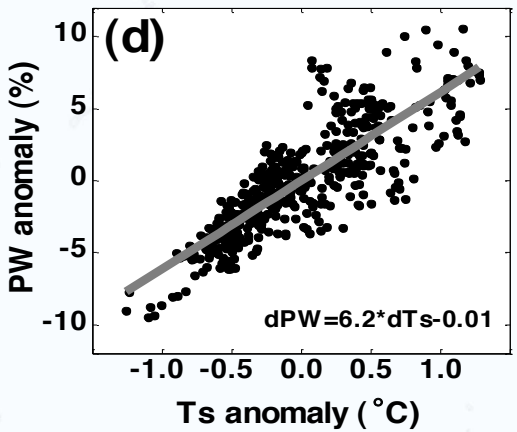
future evolution will not modify the past classification of episodes

Correlations of Atmospheric Water-vapor with Temperature over China (Zhao et al, 2012, J. Climate)



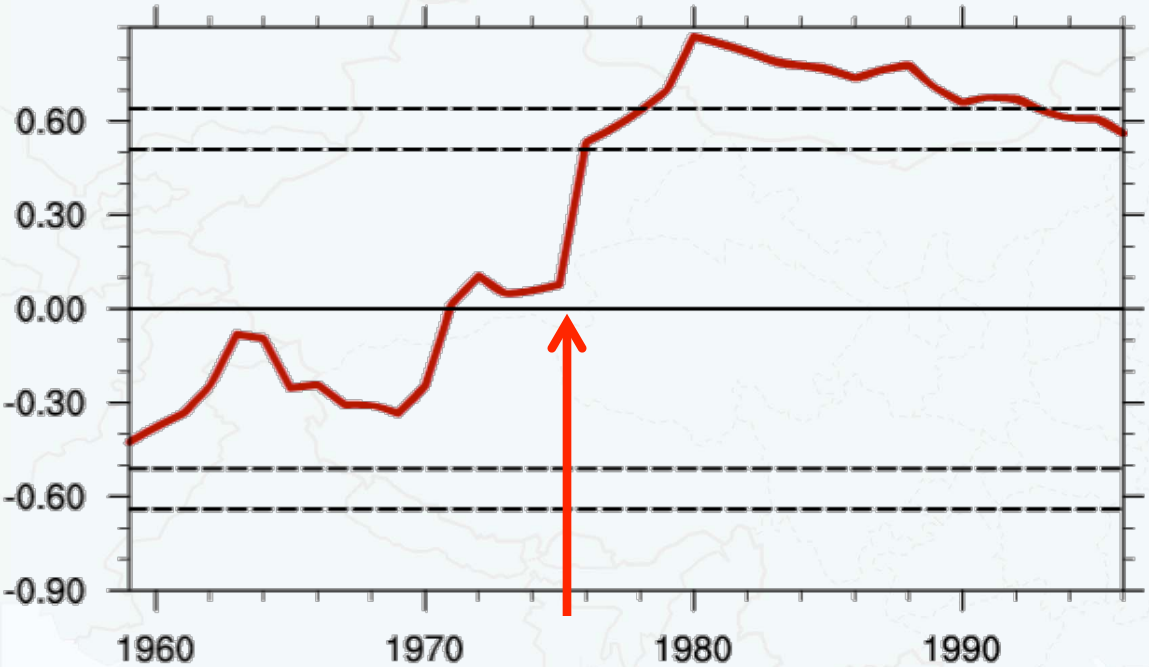


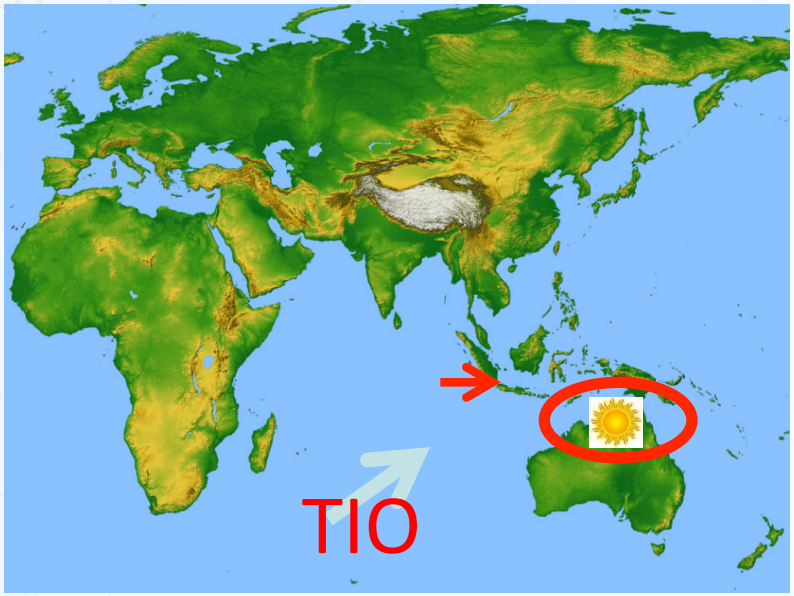




The surface-to-300 hPa precipitable water (PW) variations and long-term changes from the homogenized data over China are highly correlated with tropospheric water-vapor weighted mean temperature (Tm, R1=0.85) and surface air temperature (Ts, R2=0.83). Averaged over China, the dPW/dTm slope is about 7.6% K^{-1}, which is slightly higher than the 7% K^{-1} implied by the Clausius-Clapeyron equation with a constant tropospheric annual-mean relative humidity (RH).

The strengthened impact of TIO on East Asia climate since the late 1970s



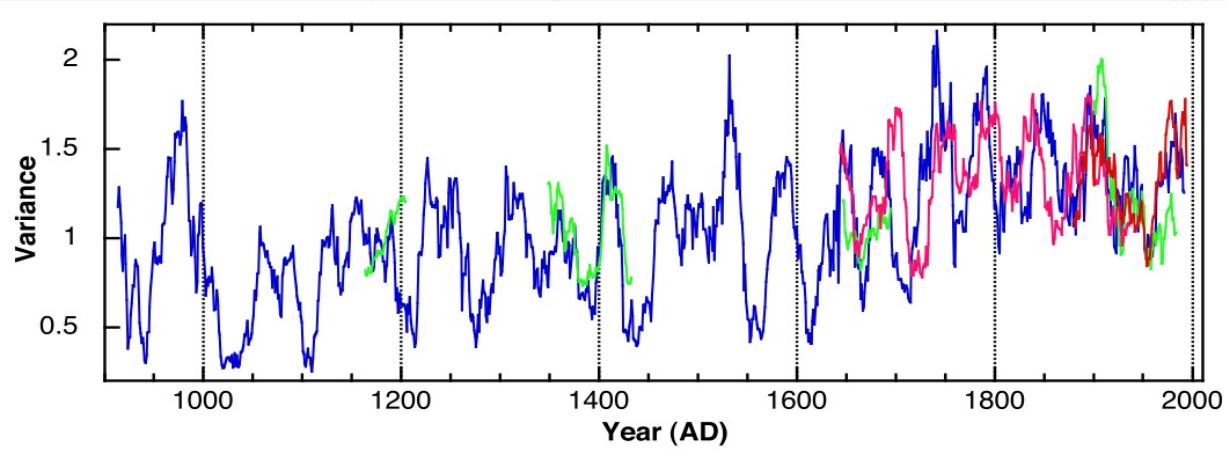


Sliding correlation coefficients between WNPSMI TIO SST index with a window of 15 years. Horizontal dash lines are denoted by 95% and 99% confidence level, respectively.

climate via a Gill–Matsuno response. Recently, Huang et al. (2010) showed that the tropical Indian Ocean–northwestern Pacific climate relationship has strengthened since the mid-1970s because of the intensification and persistence of the El Niño–induced Indian Ocean SST anomalies during the boreal summer.

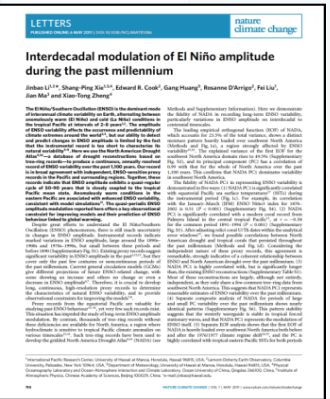
(Huang et al. 2010, J. Climate)

Interdecadal modulation of El Nino amplitude during the past millennium



The decadal change of ENSO amplitude

The results indicate that ENSO amplitude exhibits a quasi-regular cycle of 50-90 years that is closely coupled to the tropical pacific mean state


LETTERS

nature climate change

Interdecadal modulation of El Niño amplitude during the past millennium

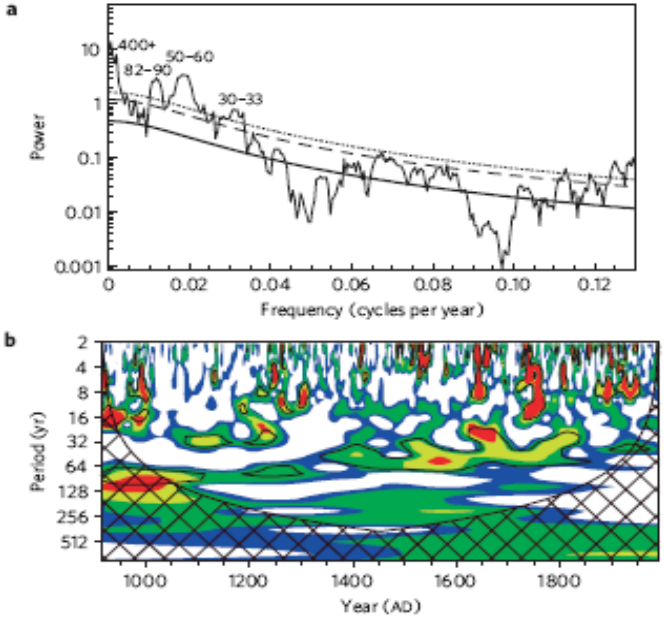


Figure 3 | Spectral property of the NADA-derived ENSO variance series. **a**, MTM (ref. 21) spectral density of the ENSO variance series. The bold line indicates the null hypothesis, and the dash (dotted) line indicates the 95% (99%) significance level, using a red-noise background spectrum. Periodicities of significant peaks are labelled above the spectral density line. **b**, The wavelet power spectrum[22]. The power has been scaled by the global wavelet spectrum. The cross-hatched region is the cone of influence, where zero padding has reduced the variance. Black contour is the 90% significance level, using a red-noise background spectrum.

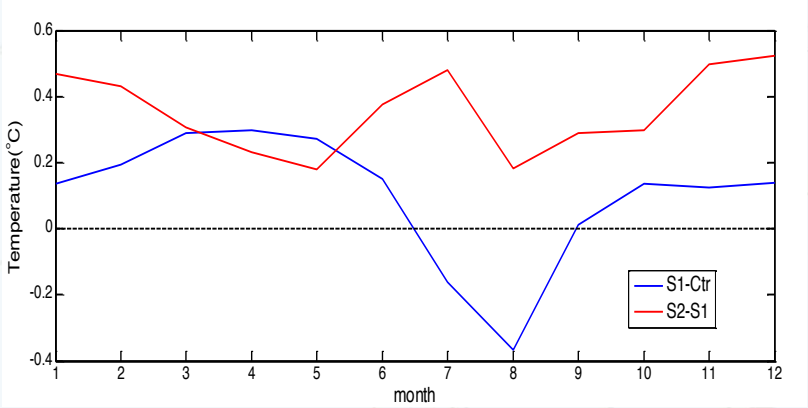
(Li J., et al, 2011, Nature Climate Change)

The simulation of impact of urbanization and it's AHR on regional climate in China

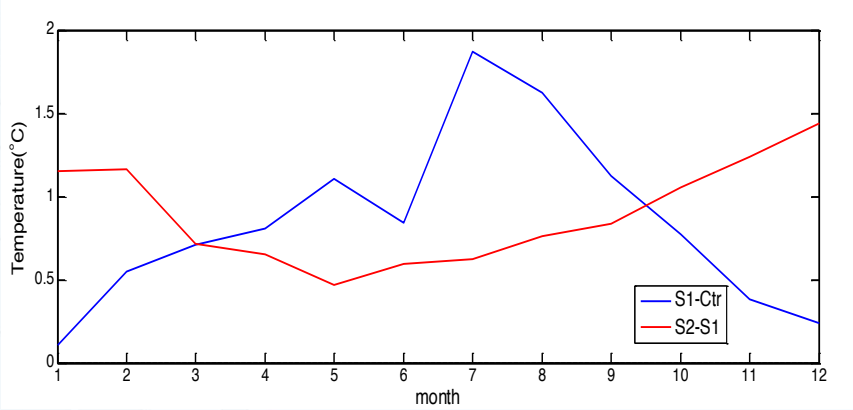
2-year simulation using WRF (2007-2008)

(Blue: USCU; Red: AHR)

Jing-Jin-Ji



Yangtze river delta

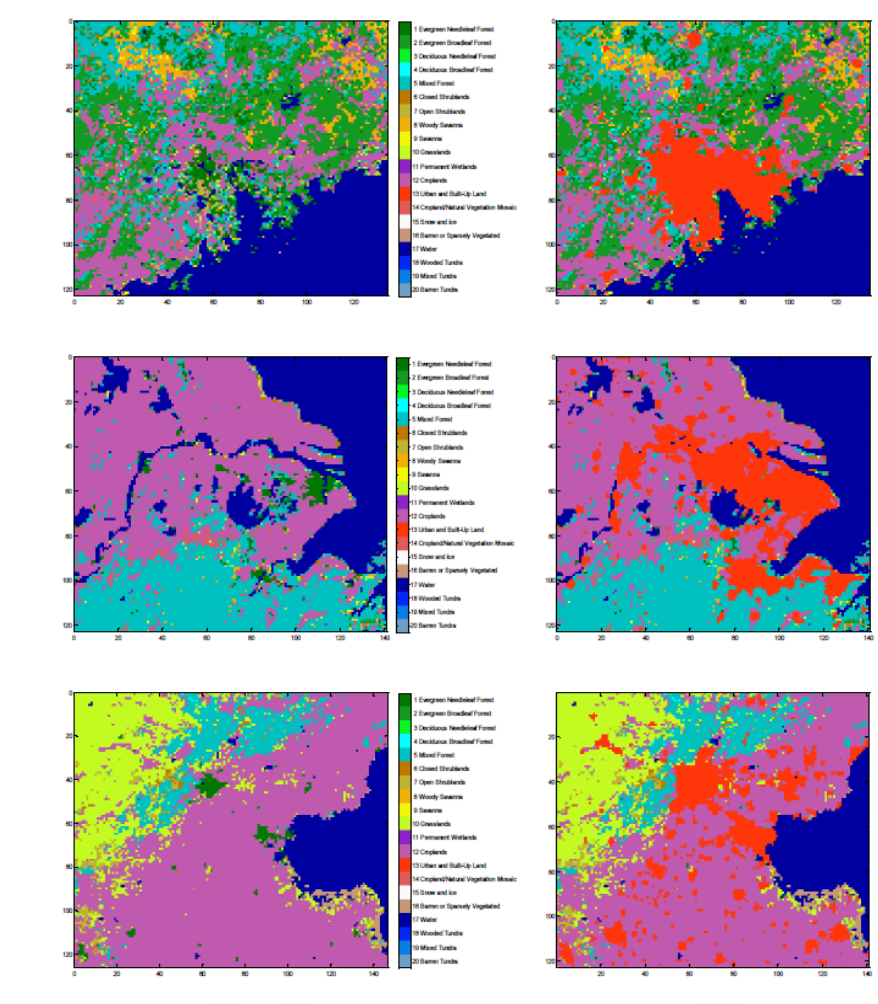


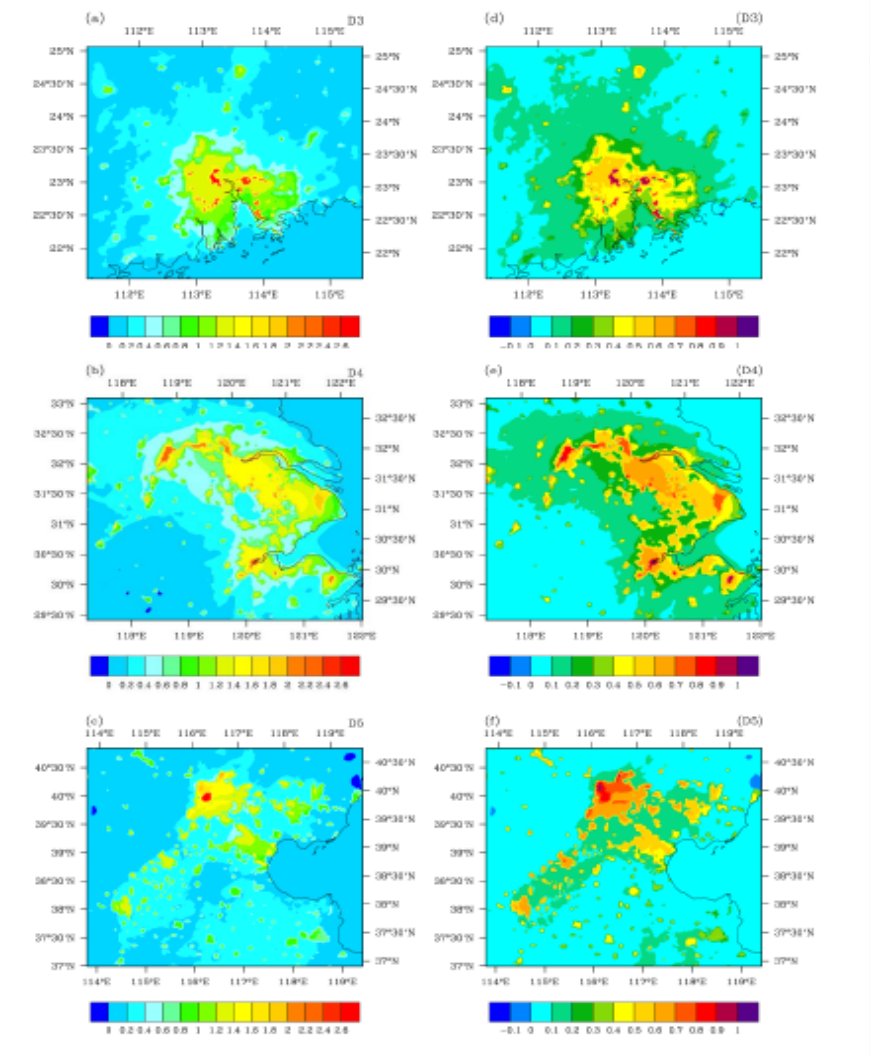
In the Jing-Jin-Ji area, the anthropogenic heat release (AHR) has a more effective influence than the underlying surface change due to urbanization (USCU) on temperature in the seasons except the spring. In the Yangtze river delta area, AHR has a more effective influence than USCU on the temperature in winter, but it is a opposite in summer.

Feng et al, 2012, J. Climate

Nested high resolution simulation over mega-cities

3-year simulation: 2007-2009; Resolution: 3.3KM





Land use from no-urban to urban

Change of annual mean T and Heat stress W

W=0.567T+0.393e+3.94

Thank You

Gensuo Jia
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http://green.tea.ac.cn

Regional Education at TEA

CAS accepts international Ph.D. and postdoc candidates, with similar requirements and benefits. Currently 2 at TEA.

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APN ARCP and CAPaBLE, annually, 20,000-80,000 USD.

Chinese Academy of Sciences

Key Lab of Regional Climate-Environment for East Asia (TEA)

Chinese Edition?

国际科学理事会（ICSU）倡议动员国际全球变化科学界，籍此史无前例的十年研究，支持全球变化背景下的可持续发展。为此，ICSU 寻求国际社会科学理事会（ISSC）和其他伙伴的密切合作。当前，人为引发的全球变化的速率和量值已然超乎人类的控制，正日益彰显其对于人类社会和福利的威胁。国际科学界亟需发展有关知识，以有助于全球公正和推进可持续发展进程的方式，传播必要的信息，以达成针对这些威胁的有效应对。在理解地球系统及其中人类活动影响的机理方面扮演了核心角色的全球变化研究界致力于满足此需求。为实现这一承诺，必须着力于新的优先研究课题和针对全球、区域、国家和局地各尺度的需求而开展和应用有关研究的新思路。作为 ICSU 及其伙伴领导下的一个国际咨询过程的结晶，本书旨在：（1）确认针对可持续发展的地球系统科学所面临的、被广泛认可的重大挑战；（2）确认应对这些重大挑战所必须开展的优先研究；（3）动员各个科学（社会、自然、健康和工程）和人文领域的学者共同推进这项研究。

Earth System Science for Global Sustain

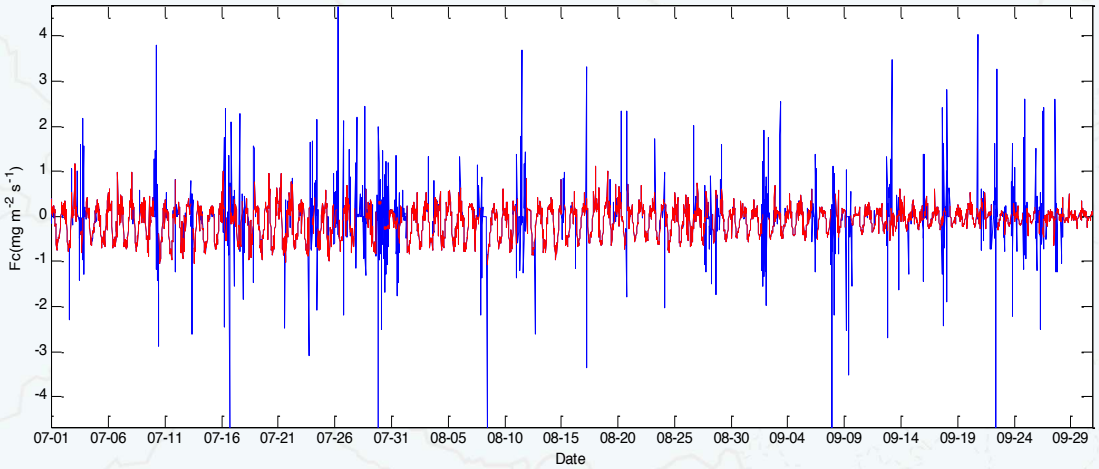
The Grand Challenges

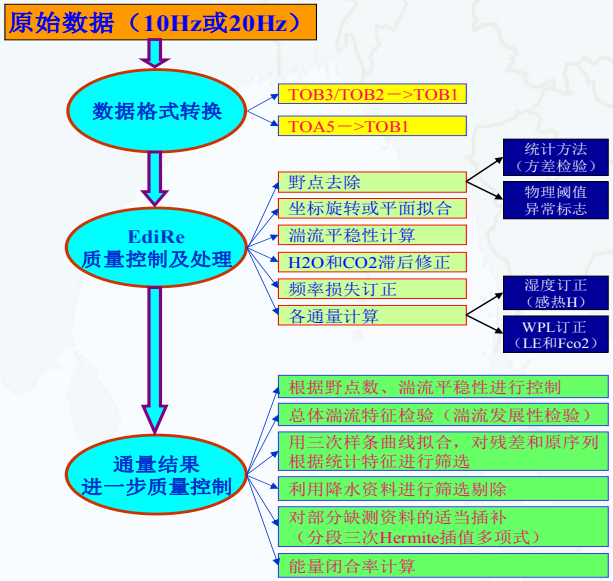
ISSC international social science council

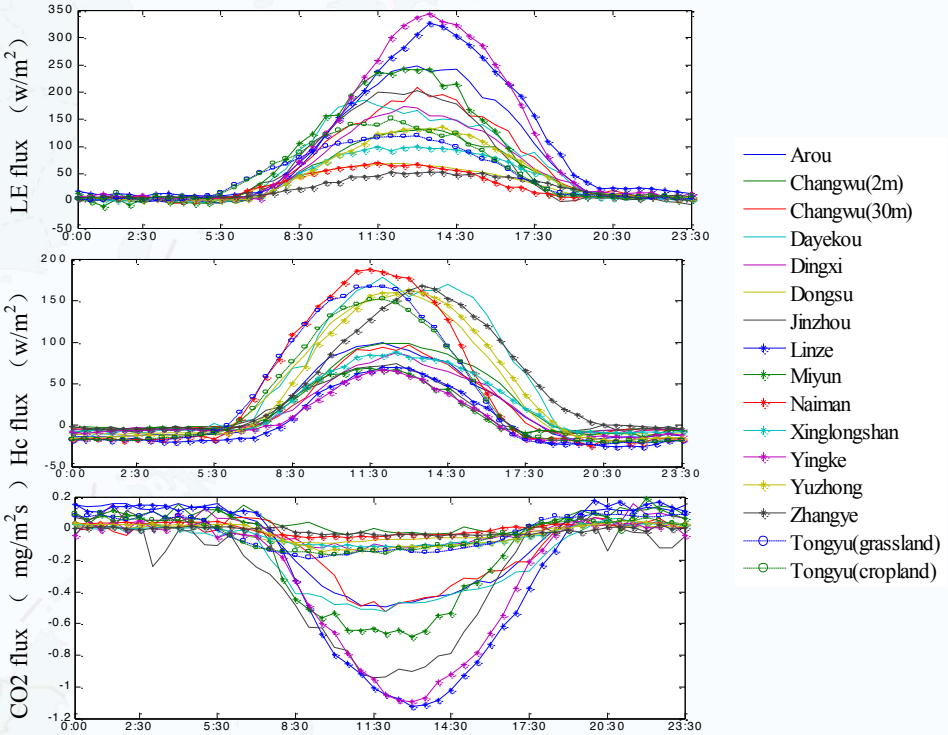
ICSU International Council

Data quality control

Before （blue）and after（red）quality control

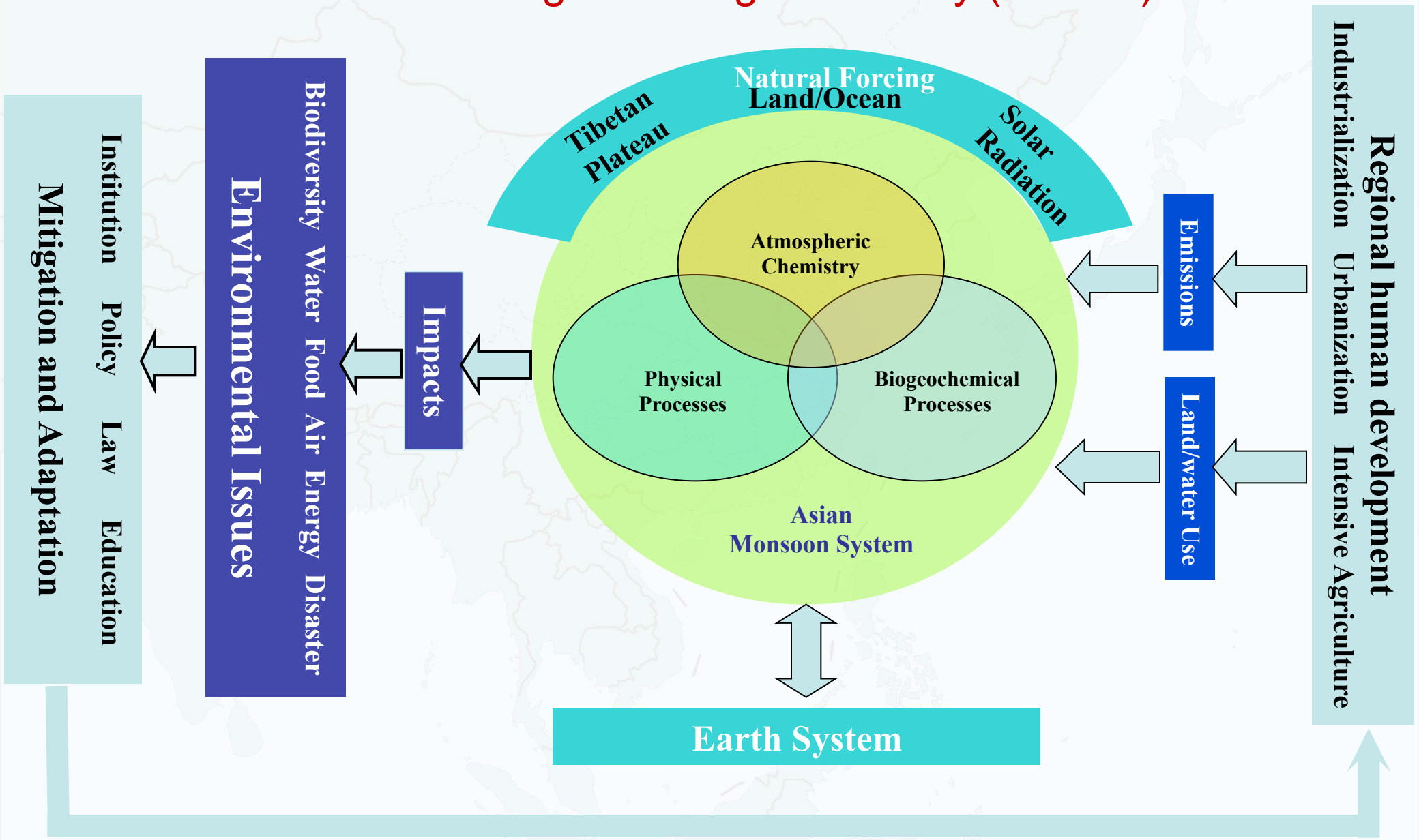




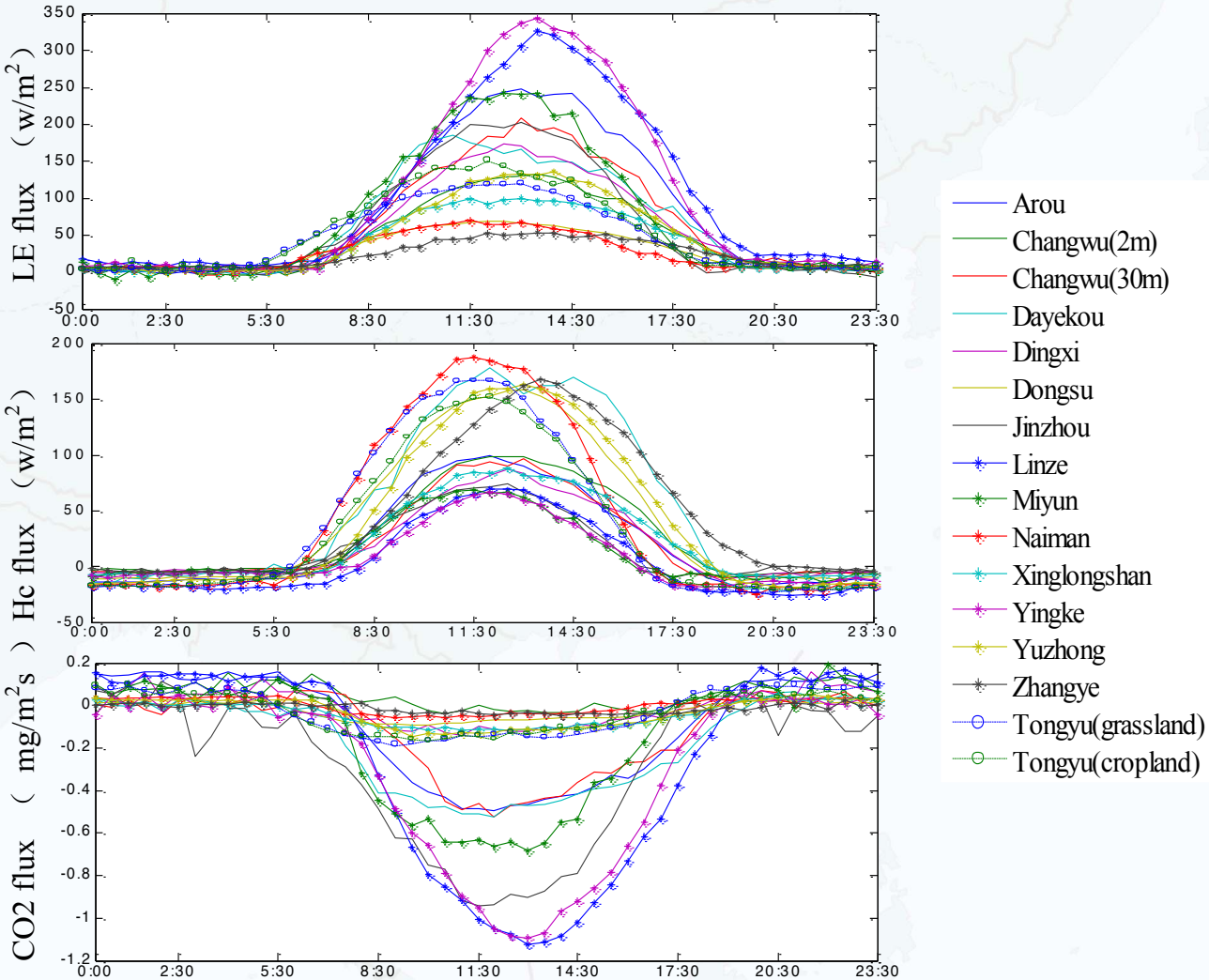


TEA Hosts: ESSP Regional Initiative

Monsoon Asia Integrated Regional Study (MAIRS)



Coordinated Flux Data



Regional Capacity Building

Training workshops on *in-situ* observation of land-atmosphere interactions in semi-arid regions, Lanzhou, July 2008.

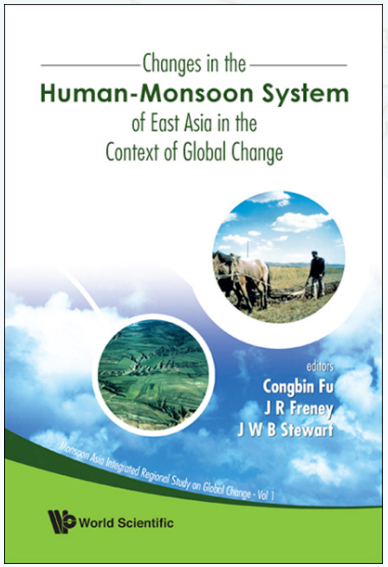
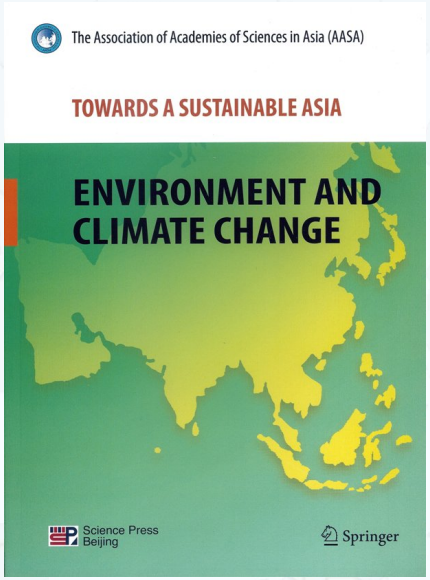
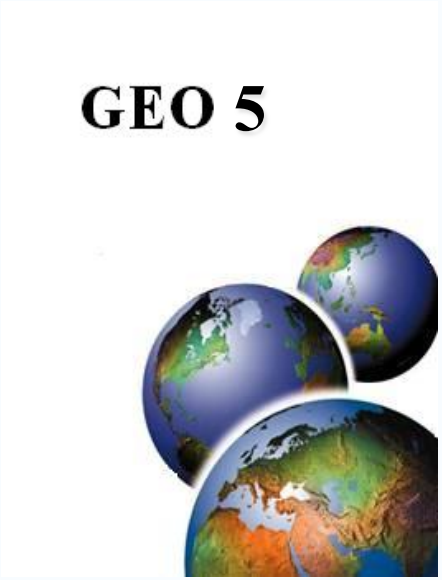
Workshop on environment and natural resources for sustainable Asia, Izmir, Turkey, November 2009.

Training course on "Remote sensing methods for rangeland degradation and climate change studies" for Central Asia, Almaty, Kazakhstan, September 2009. (Trainer)

Summer school on ecosystem conservation and climate change in China-Mongolia-Russia "Dauria" Nature Reserve, Dauria, July 2011. (Trainer)

Regional and Global Synthesis

Fu, C., J.R. Freney, J.W.B. Stewart, 2008, Changes in the Human-Monsoon System of East Asia in the Context of Global Change, World Scientific.

Jia, G., C. Fu, et al, 2011, Towards a Sustainable Asia: Environment and Climate Change, Springer.

UNEP GEO-5 (2012): Climate change and water.