

# Monsoon Asia Integrated Regional Study (MAIRS) and its Recent Progresses

Ailikun, Jiaguo QI\*

MAIRS IPO

Institute of Atmospheric Physics,  
Chinese Academy of Sciences

\*Michigan State University

# Monsoon Asia Integrated Regional Study (MAIRS)-an IRS project under ESSP (from 2006)



Earth System

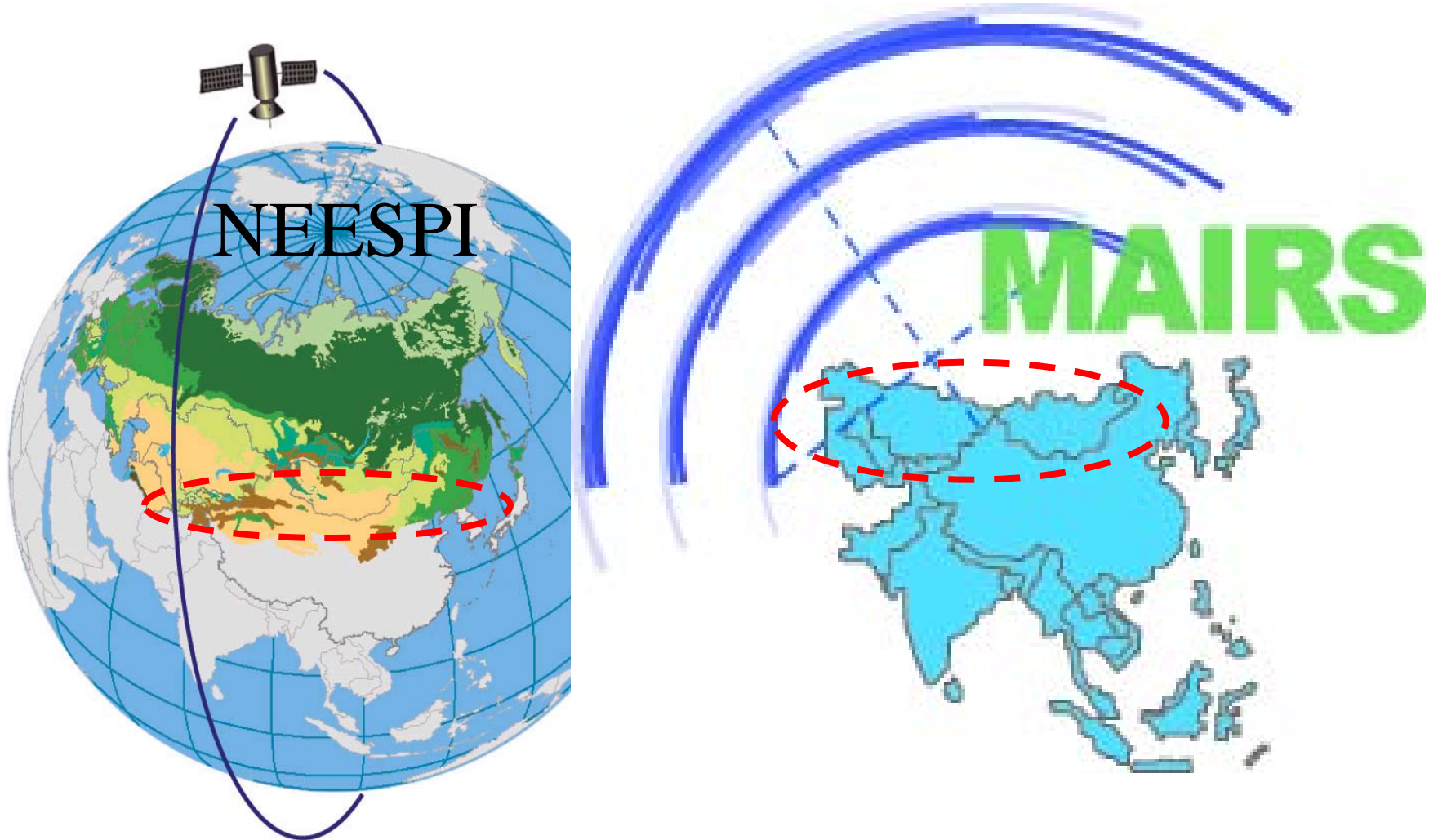


The vision of MAIRS is "To significantly advance the understanding of the interactions between the **human-natural components** of the overall environment in the monsoon Asian region, and implications for the global earth system, in order to support strategies for sustainable development."

INASA S LCLUC program.






# MAIRS Region

Geographic overlap: Arid and semi-arid regions

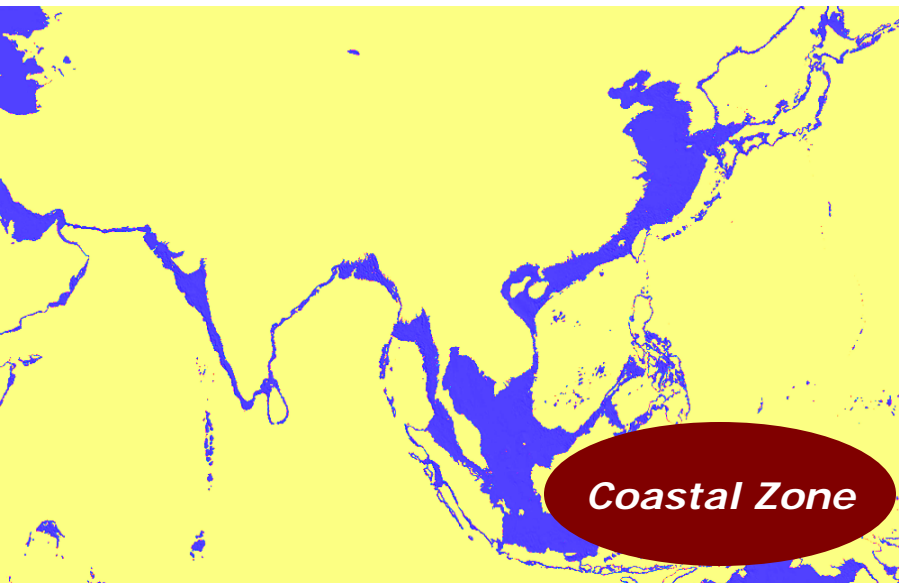


# MAIRS focuses on:

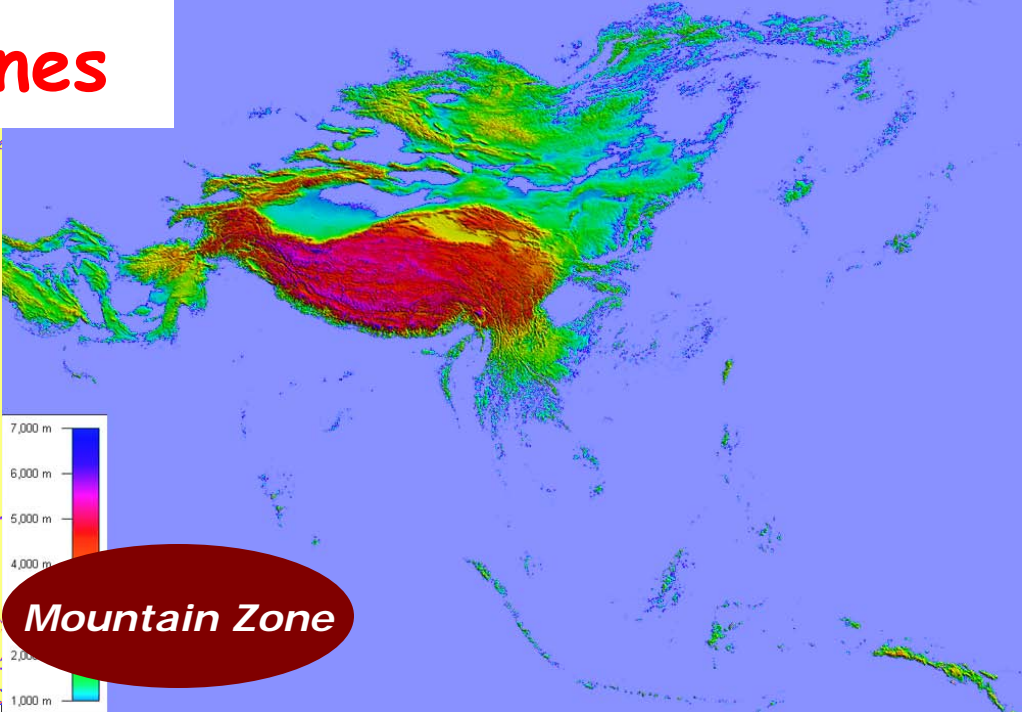
## Integration

-  multi-disciplinary
-  vulnerable zones
-  key issues
-  observing systems
-  multi-models

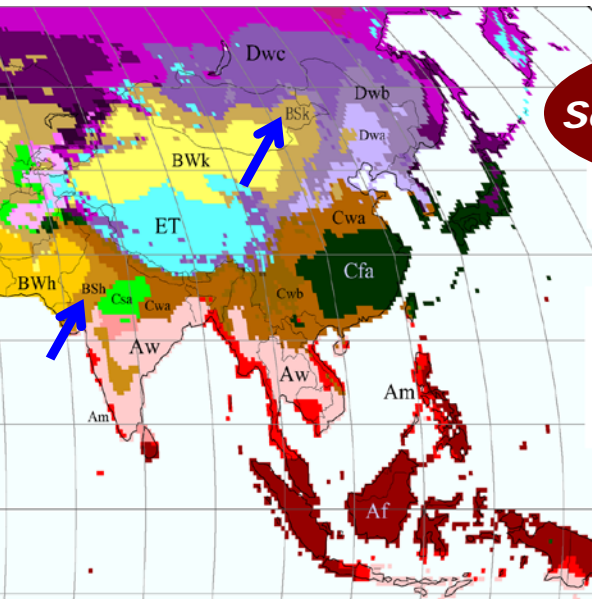
# MAIRS Integration Zones



**Coastal Zone**



**Mountain Zone**

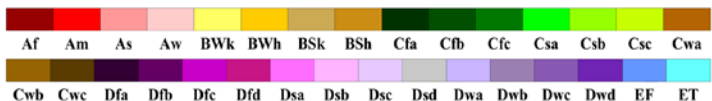


**Semi-arid Zone**

**Urban Zone**

D: summer dry  
E: polar  
w: winter dry  
m: monsoonal

**Temperature**  
h: hot arid  
k: cold arid  
a: hot summer  
b: warm summer  
c: cool summer  
d: extremely continental  
F: polar frost  
T: polar tundra



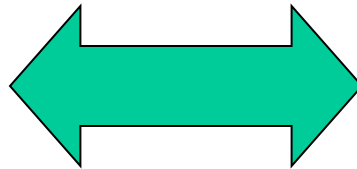
■ 2-3 million inhabitants  
■ 3-5 million inhabitants  
■ 5-10 million inhabitants  
■ More than 10 million

# Key Issues

 *Water*

 *Land*

 *Air*

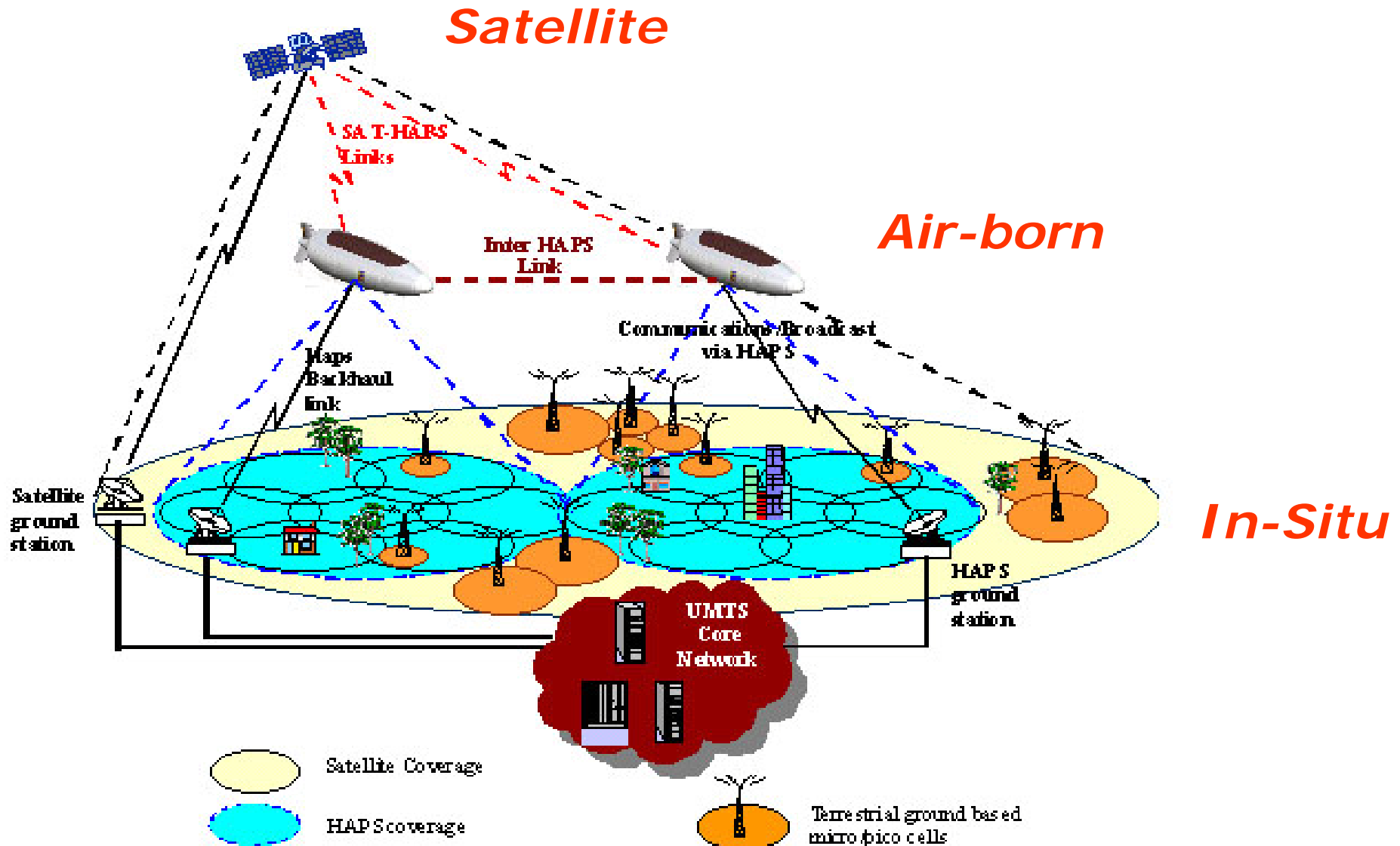


 Coastal  
Mega-cities

 Drylands

 High  
Mountains

# Integration of the Observing Systems



# Major scientific research activities

1. **Aerosol-climate interaction** (iLEAPS-ACPC, IGAC/IGBP, AMY/WCRP)
2. **Land cover change -climate interaction** (NASA LCLUC/NEESPI, CEOP GEWEX/WCRP, GLP/IHDP, iLEAPS, GCP)
3. **Regional modeling and future projection** (CORDEX/WCRP, AIMES/IGBP and other modeling groups)



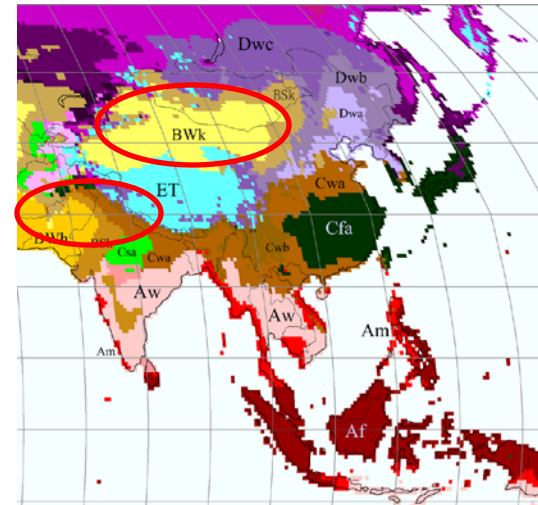


# MAIRS hotspots studies in developing

- 1 , Dryland Study
- 2 , Mega-city study
- 3 , Regional earth system modeling

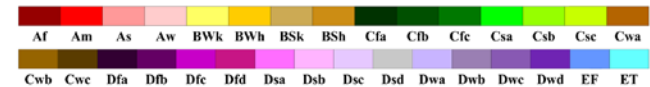
# 1, MAIRS Dryland Study

- Water resources and ecosystem service goods are crucial to the people living in dryland regions
- Dryland regions are sensitive to climate variation and human perturbations
- Dryland areas in monsoon Asia are the major sources of dust aerosol



Main climates	Precipitation
A: equatorial	W: desert
B: arid	S: steppe
C: warm temperate	f: fully humid
D: snow	s: summer dry
E: polar	w: winter dry
	m: monsoonal

Temperature	
h: hot arid	F: polar frost
k: cold arid	T: polar tundra
a: hot summer	
b: warm summer	
c: cool summer	
d: extremely continental	



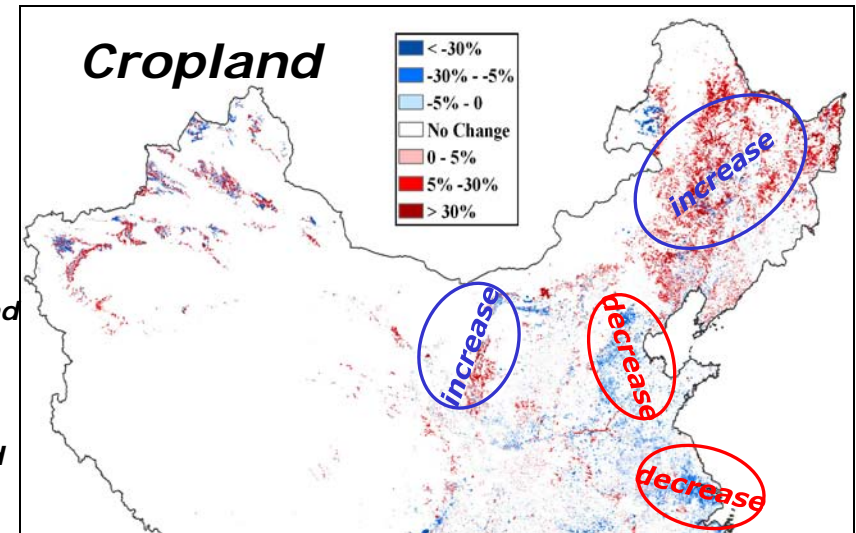
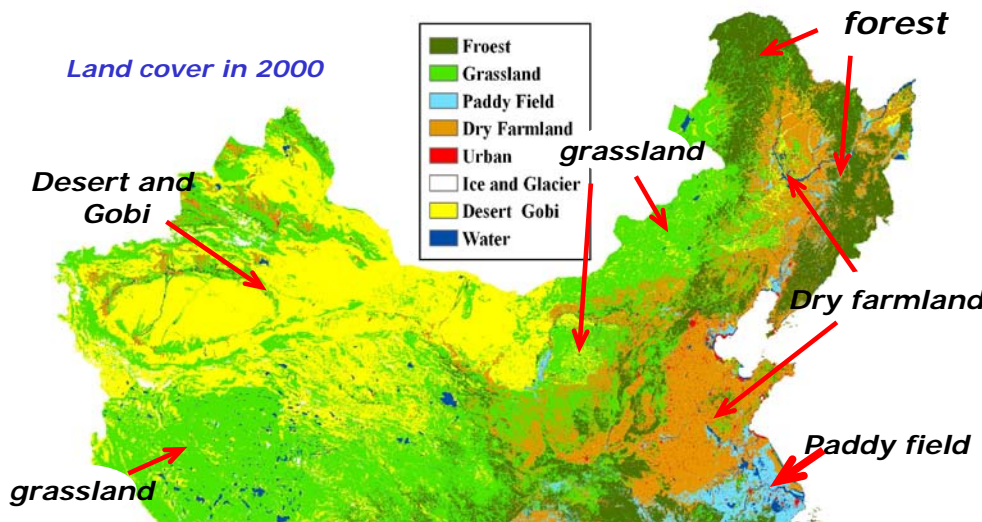
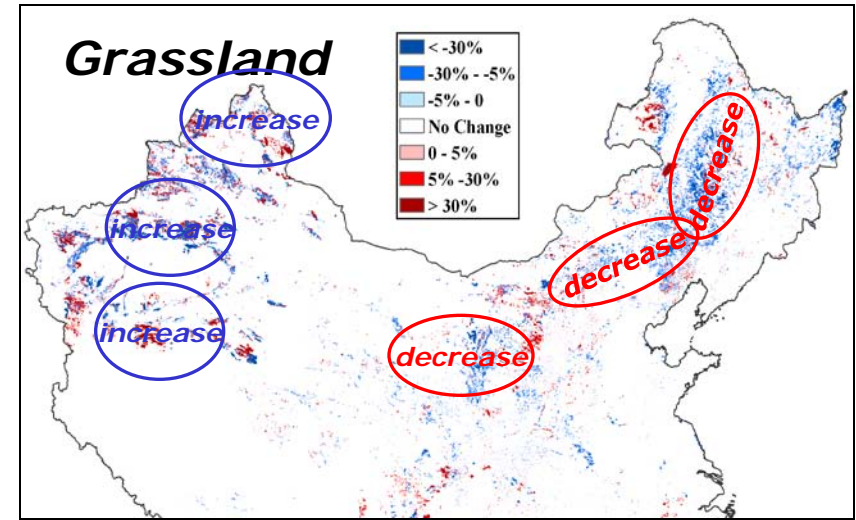
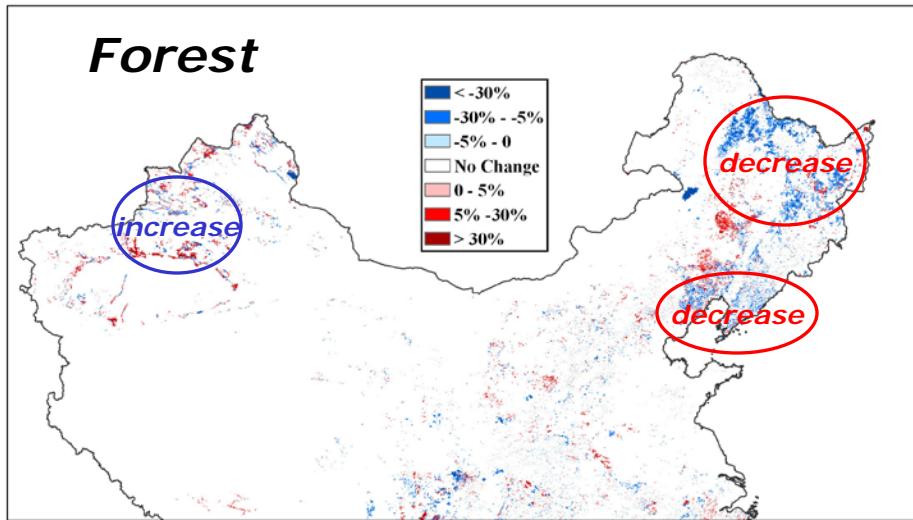
## Desertification rate over Northern China (Cai, 2005)

**Before mid 1970's: 0.15 million hectare/year**

**mid 1970's to 1980's: 0.21 million hectare/year**

**After 1990's: 0.25 million hectare/year**

# Land cover/use change in dryland China from 1980 to 2000

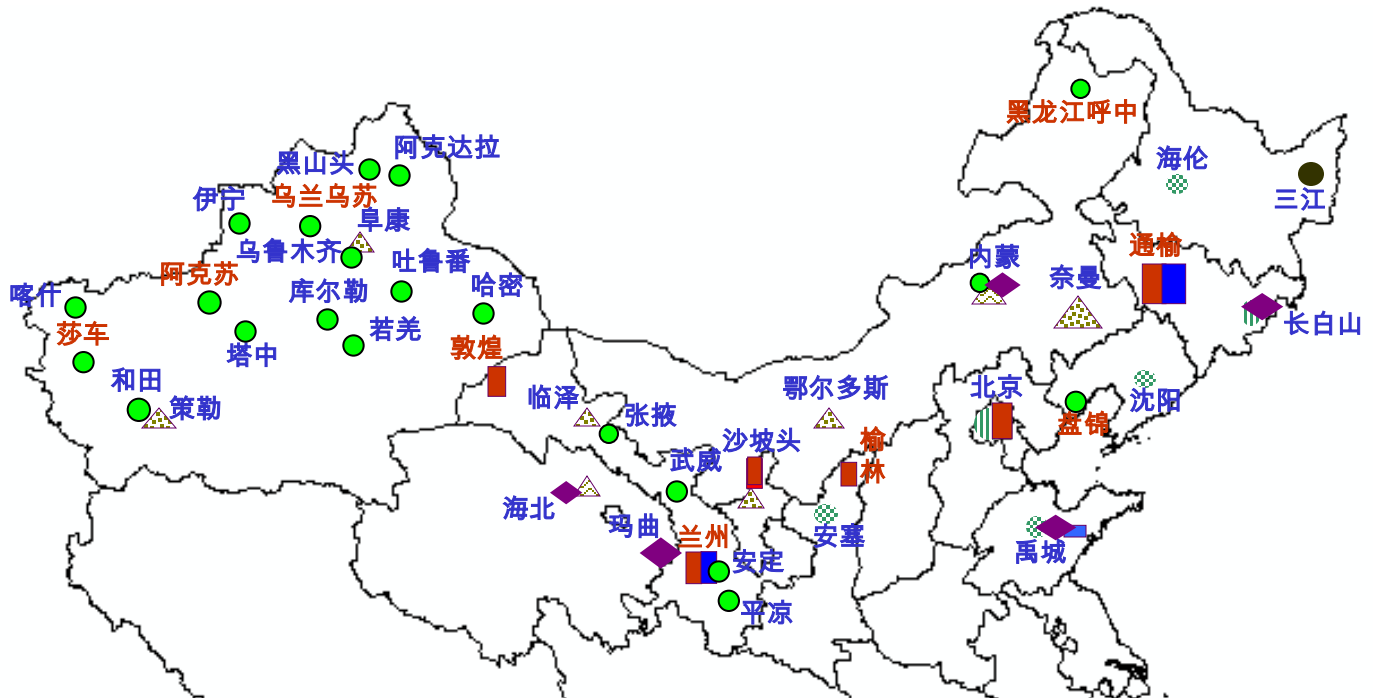


# Existing Intensive Observation Stations in Northern China (~40)

■ 国际CEOP标准站  
◆ China Flux站

■ 沙尘观测站

● 项目自建站

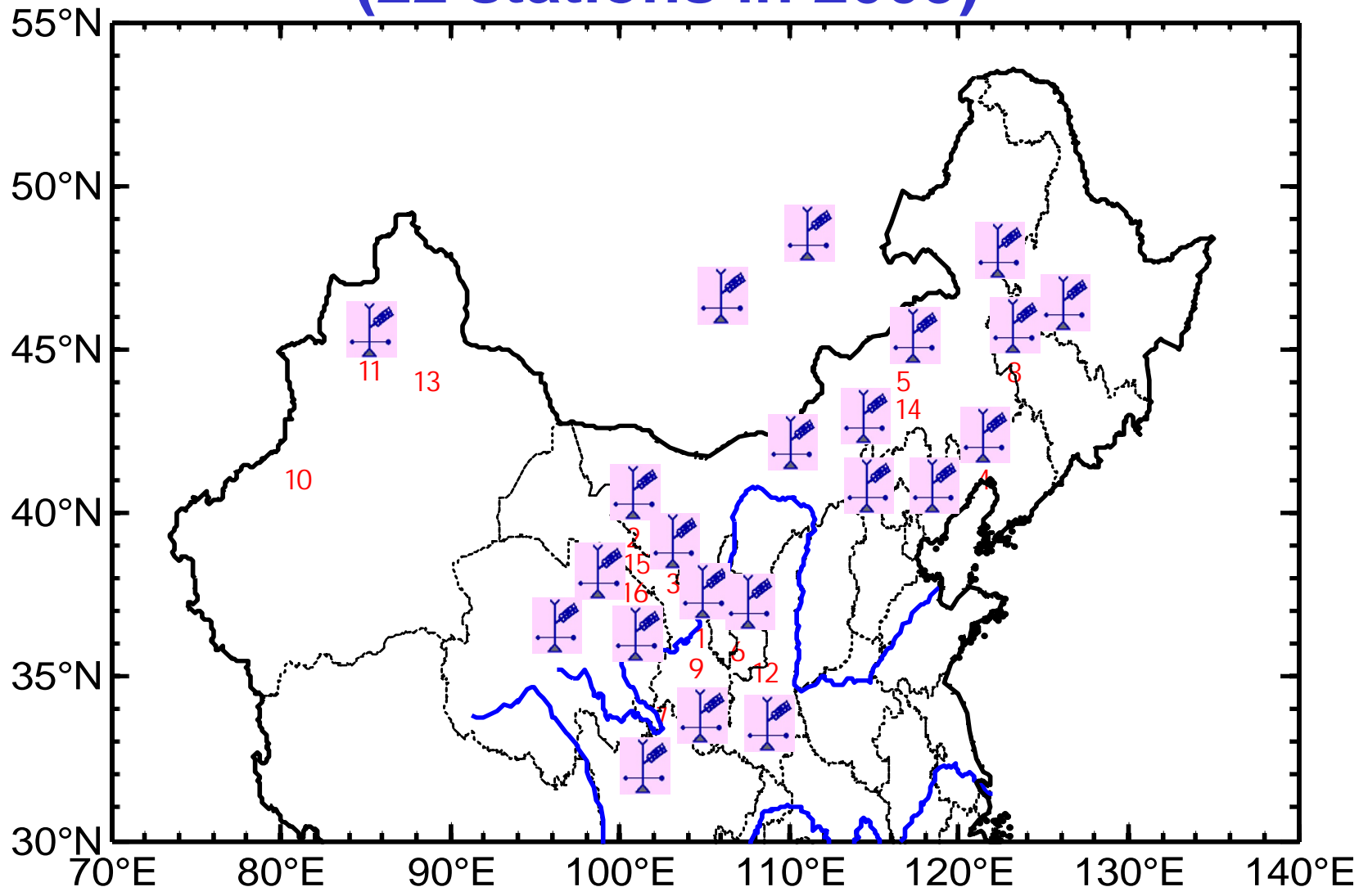


中国生态系统定位研究站 ( CERN)

<span style="color: green;">■</span> 农田	<span style="color: blue;">■</span> 海湾
<span style="color: green;">■</span> 森林	<span style="color: cyan;">■</span> 湖泊
<span style="color: green;">■</span> 草地	<span style="color: brown;">●</span> 湿地
<span style="color: green;">■</span> 荒漠	

- Lack of data sharing
- No joint equipment calibration
- No joint data quality control
- Lack of regional integration

# MAIRS dryland observing network (22 stations in 2009)



# Participant institutes

1. Institute of Atmospheric Physics, CAS
2. Cold and Arid Regions Environmental and Engineering Research Institute (CAREERI), CAS
3. Lanzhou University
4. Beijing Normal University
5. Gansu Provincial Meteorological Bureau, CMA
6. Institute of water and soil conservation, CAS
7. Institute of Botany, CAS
8. Xinjiang Provincial Meteorological Bureau, CMA
9. Northeast Normal University

# Experts Workshops

**1<sup>st</sup> national workshop on  
integrated dryland study**

**27-29<sup>th</sup> Jun, 2007**

**Beijing**



**2<sup>nd</sup> National workshop  
on integrated dryland  
study**

**10<sup>th</sup> Dec, 2007**

**Beijing**





# Dryland Main Research Agenda

- 1) The structure and characteristics of atmospheric boundary layer under different land surface
- 2) water and energy cycle of land-atmosphere processes in dryland region.
- 3) Methods of scale conversion from one point observation to local/regional scale and vice-versa
- 4) Physical/chemical characteristics of dust aerosol and its interaction with local/regional climate

# Training courses for Young Scientists

**1, Basic theory of ABL, land surface processes and aerosol**

**2, Equipment placement and setting**

**3, Observation guideline**

**4, Data archive and quality control**



**1st Training courses on flux observation, 11-13<sup>th</sup> Dec, 2007, Beijing**

**2nd training course on flux data quality control, 17-18 July, 2008, Xian**



*Calibration 2008*



	Ground Meteeoro.	Wind, temperature humidity in near surface levels	Radiati on	Heat and CO2 flux	Soil temp, soil moisture	ecosystem	aerosol
阿克苏	√	√	√	√	√	×	×
奈曼	√	√	√	√	√	×	×
阿柔冻融	√	√	√	√	√	×	×
大野口	√	√	√	√	√	×	×
盈科	√	√	√	√	√	×	×
临泽	√	√	√	√	√	×	×
玛曲	√	√	√	√	√	×	×
榆中	√	√	√	×	√	×	×
兴隆山	√	√		√	√	√	√
长武	√	√	√	√	√	√	√
安塞	√	√	√	√	√	√	×
张掖	√	√	√	√	√	√	×
定西	√	√	√	√	√	√	√
通榆 (退化 草地)	√	√	√	√	√	√	√
通榆 (农田)	√	√	√	√	√	√	√
东苏	√	√	√	√	√	√	×
锦州	√	√	√	√	√	√	×
密云	√	√	√	√	√	×	×

# Main Observing Agenda

- 1) Atmosphere boundary Layer
- 2) Land surface processes (including the surface water/energy/carbon flux, soil T/M/heat flux)
- 3) Dust Aerosol
- 4) Ecosystem
- 5) Remote sensing products on land cover details

# Intensive Observation Period in summer of 2008 and 2009

- 1) 18 stations joined the 2008 IOP in 1 July-30 September, equipment (flux) calibration in June 2008
- 2) Data quality control finished by 15 Dec 2008, and being shared with participating groups from 31 Dec 2008.
- 3) 22 stations are joining the 2009 IOP from 1 June to 30 Sep., calibration finished in May 2009

# Set up MAIRS Dryland Working Group on “Coupled Human-Environment Systems (CHE)”

## Objectives:

To assess the vulnerability of dryland Coupled Human-Environment (CHE) systems in the MAIRS region and to develop and evaluate various coping strategies to global changes in the MAIRS dryland region.

# Scope of the Effort

1. Evaluate the climate and other global change trends on the CHE of dryland systems
2. Identify critical drivers, trade-offs and thresholds on the vulnerability of the coupled human-environment system relative to sensitivity, impacts, and adaptive capacity of various system components in the MAIRS dryland region
3. Model stresses, impacts and responses of CHE in the MAIRS dryland region
4. Evaluate coping mechanisms to deal with vulnerabilities related to building socio-ecological resilience and to developing adaptive strategies in the dryland MAIRS region.



**Thank You!**

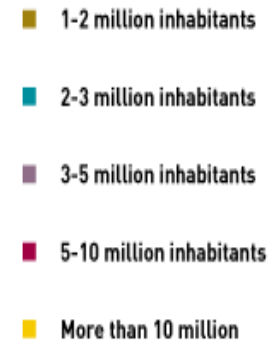
Questions about Dryland Studies

## 2, MAIRS Mega-city Study

■ In 2000, about 47 % of the world's population, and 30% of Asian population lived in urban areas.

■ Of the 10 world's most populous urban agglomerations, 6 are in Asia

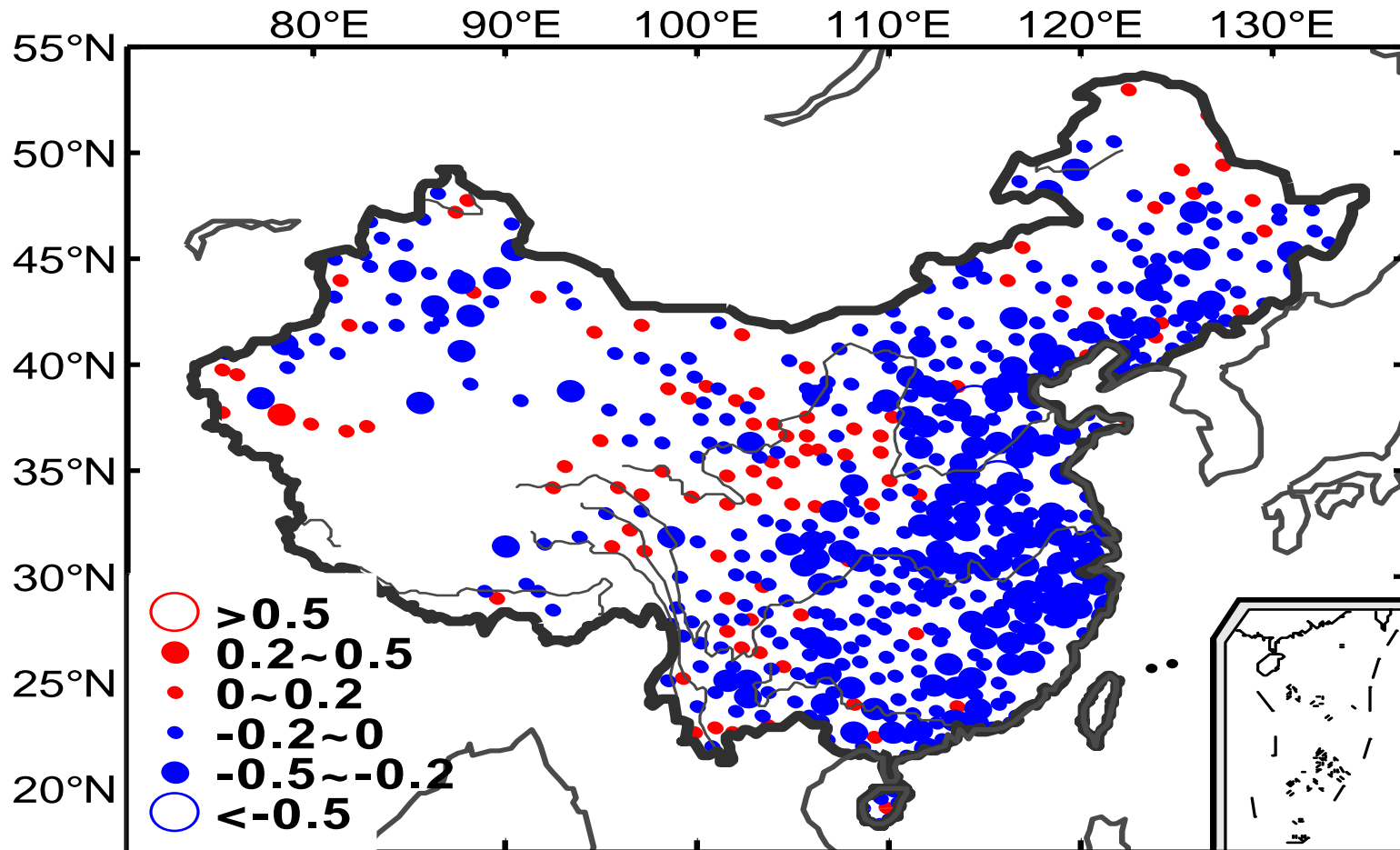
■ by 2015 there will be 358 cities worldwide with population of over a million people; of them 153 are expected to be in Asia. Of an estimated 27 mega-cities (exceeding a population of ten million), 15 will be in Asia.



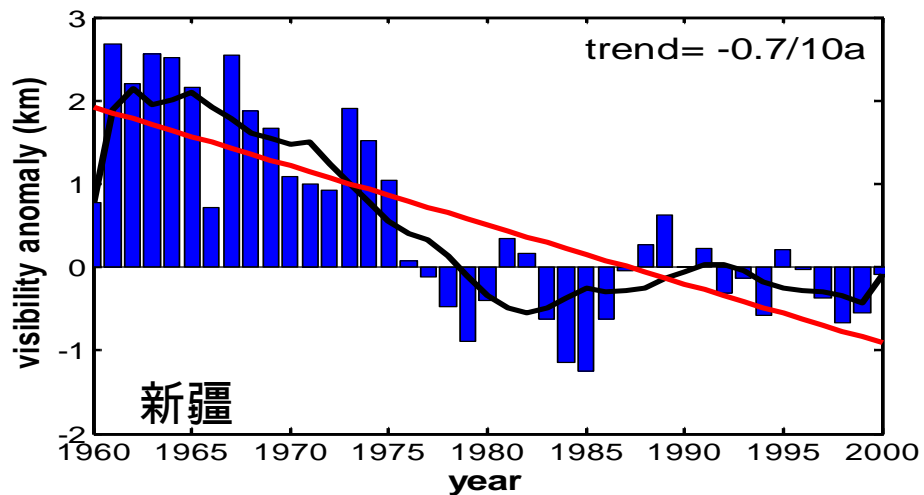
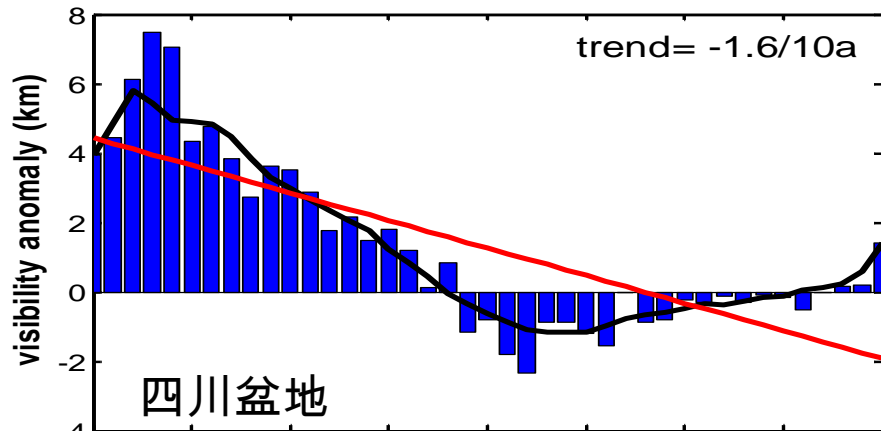
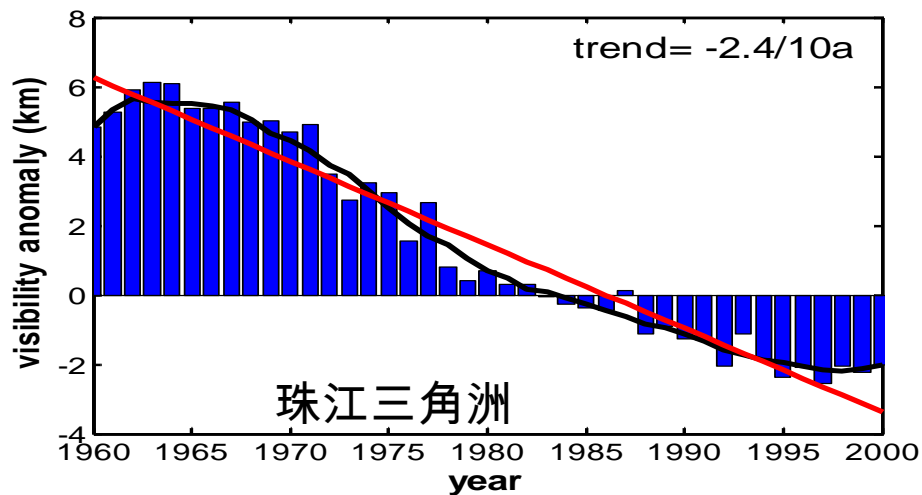
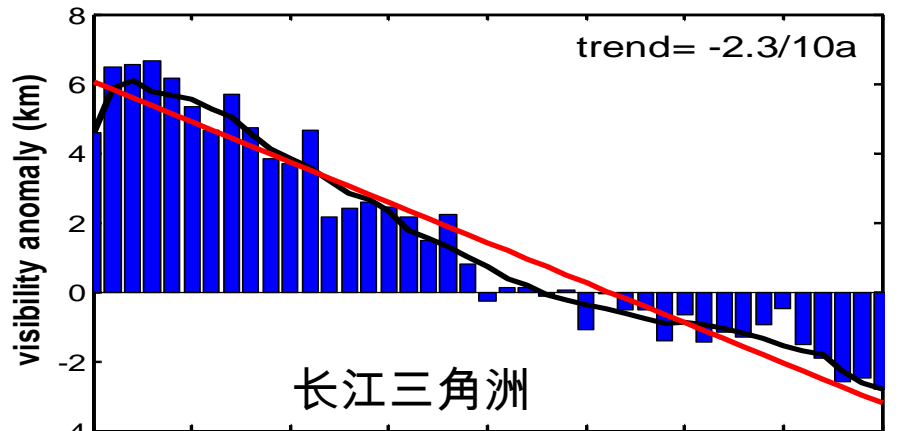
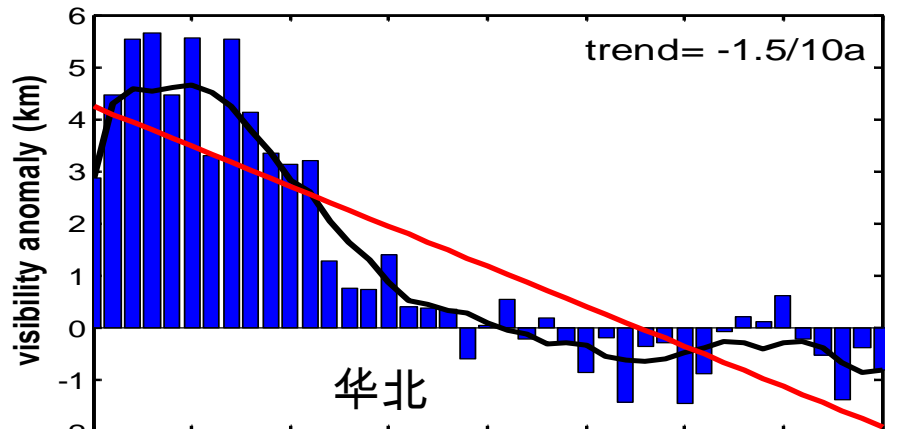
Tokyo



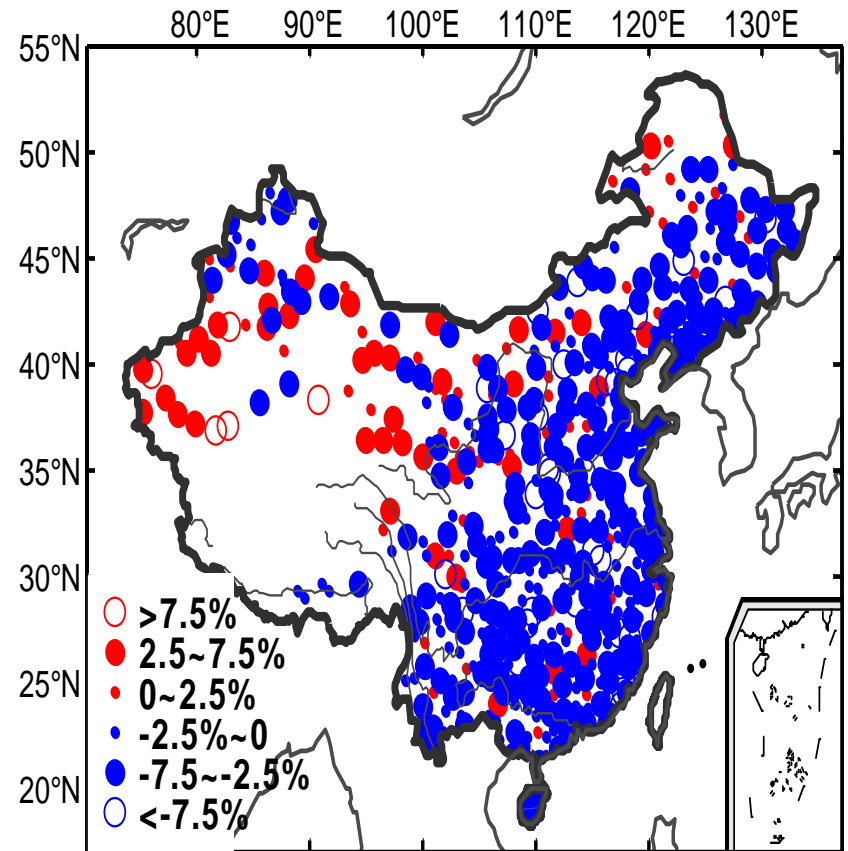
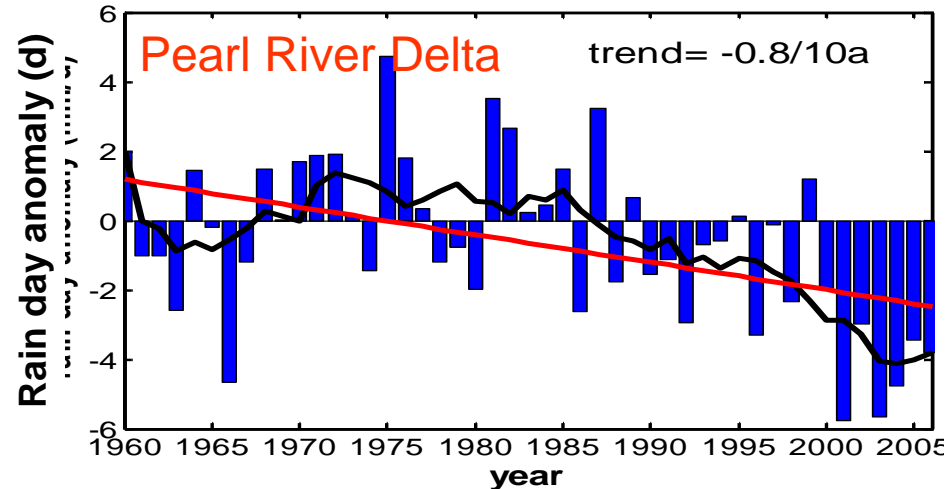
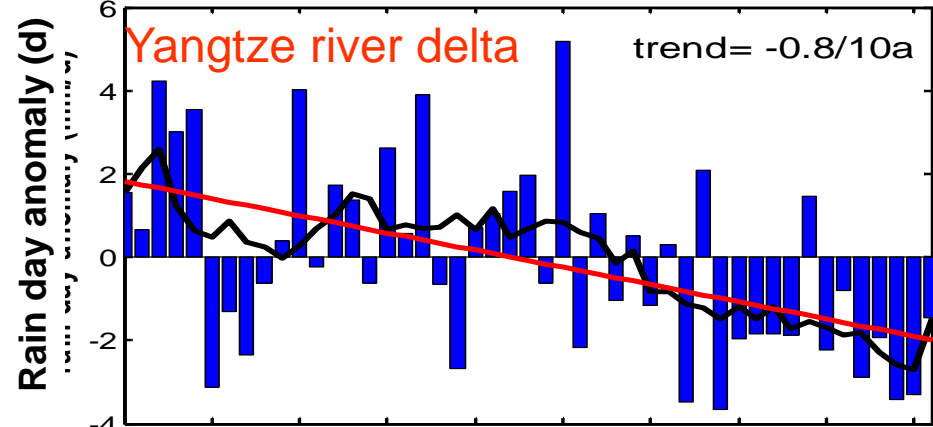
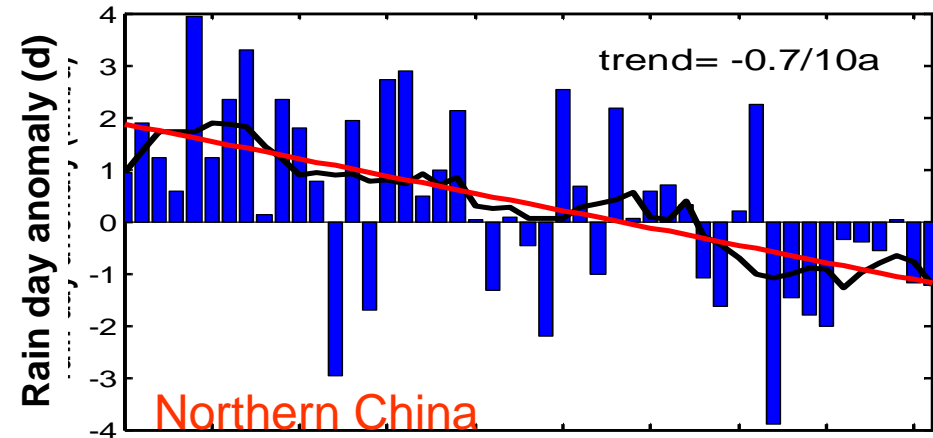
# Change in sunshine duration ( hr d<sup>-1</sup> in 10 years due to aerosols, T. Zhao et al., 2007)



# Change of visibility (km) in China 1960-2005



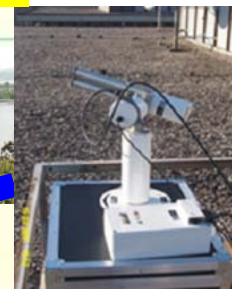
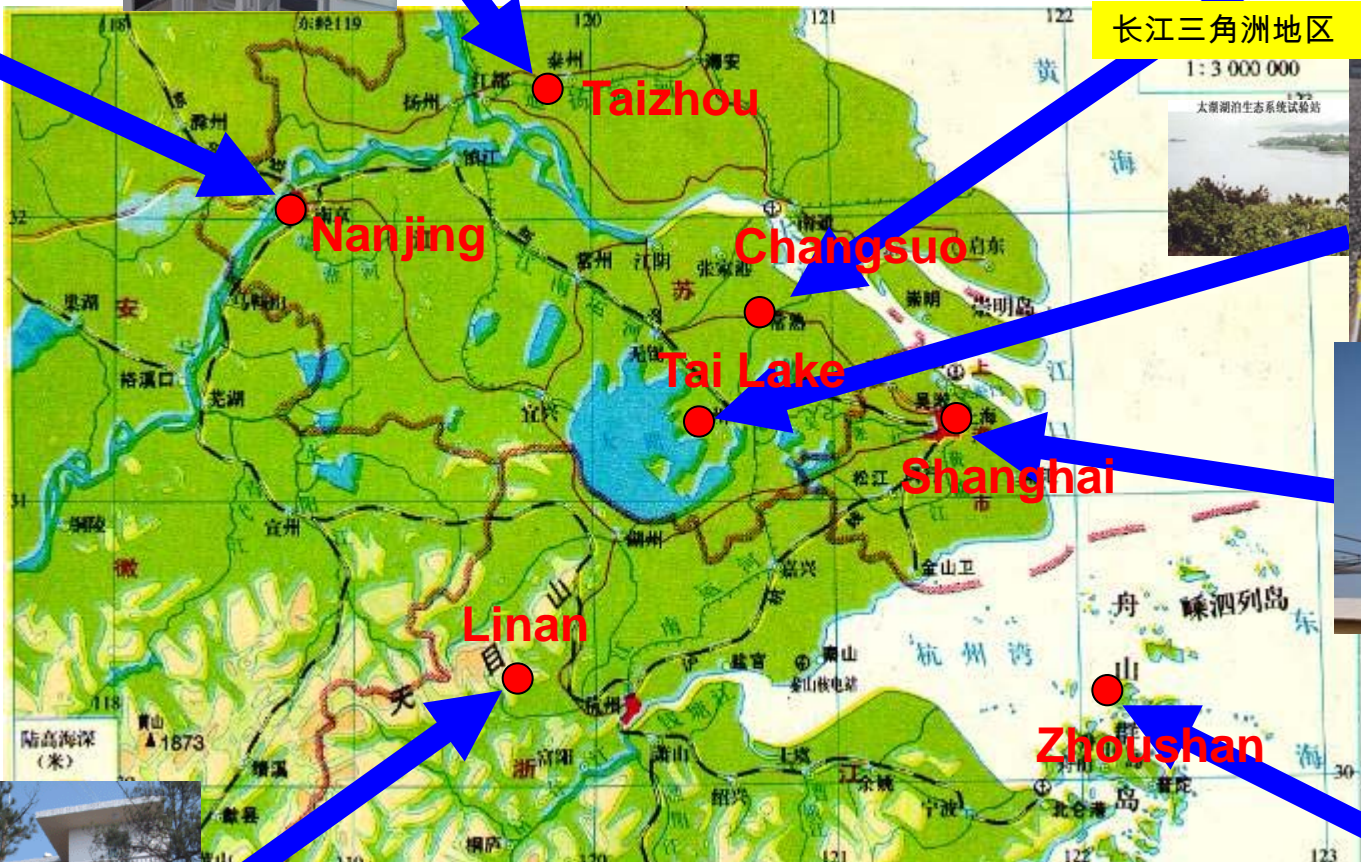
# Change of days of light rain (<1.0 mm) May-Sep 1960-2005



# Main Research Agenda

- ✦ Aerosol-climate interaction
- ✦ Urbanization, Land cover change and local/regional water cycle
- ✦ Mega-city risk assessment/management
- ✦ Energy, emission and human health

# Observation network in city cluster of Yangtze Delta



# 3, Regional Model Inter-comparison Project—RMIP

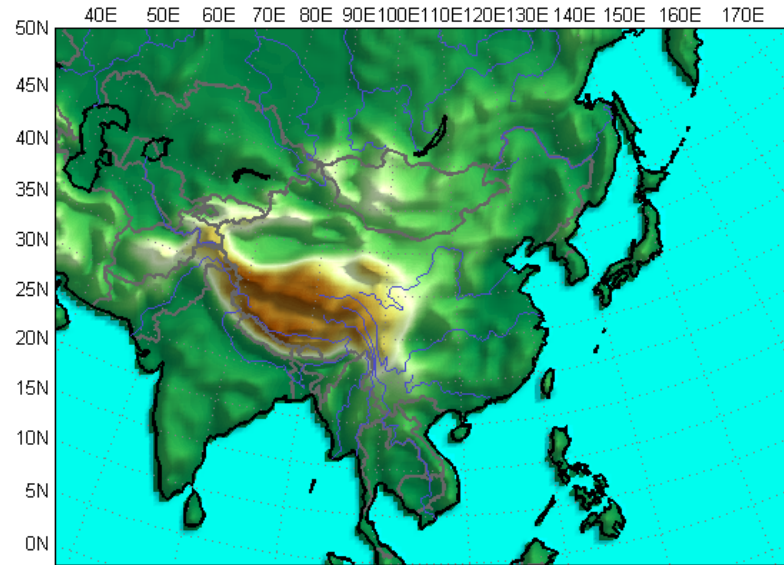
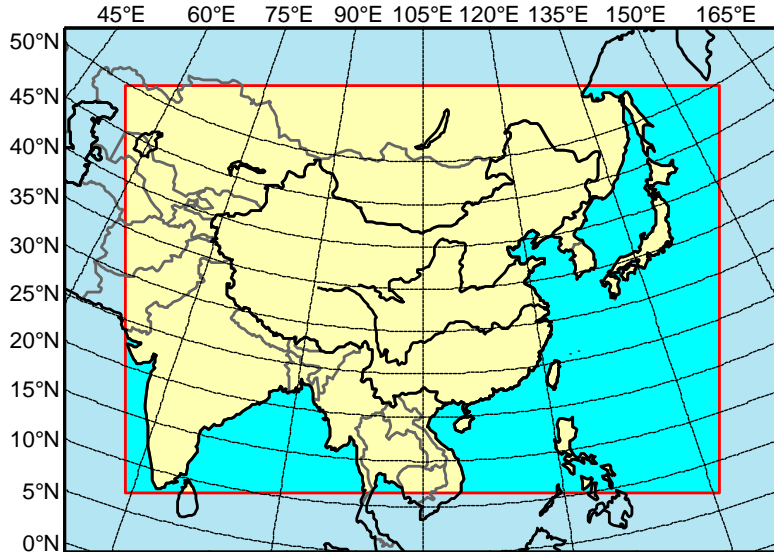
**Building Asian Climate Change  
Scenarios by Multi-Regional Climate  
Models Ensemble**



# Tasks of RMIP for Asia

- Phase I, 18 months run (1997-), annual cycle and extreme, 2002-2004
- Phase II, 10 years run (1989-1998), statistical behaviors, 2004-2007
- Phase III, nesting with GCM, projection of regional climate in 21 Century, 2008-2010

# Simulation Design



- ✦ **Integration Domain:** (45-165E, 0-45N)
- ✦ **Resolution:** 60KM (for whole area, downscaling to 30KM in some key areas)
- ✦ **Participating Countries:** China, Japan, Korea, Australia, US
- ✦ **Regional Models:** 6 models in RMIP II, and 9 models in RMIP III
- ✦ **Global models:** 2 GCM outputs as driving fields
- ✦ **Simulation Periods:** 1978-2000 for control, 2038-2070 for projection, A 2-year spin-up time is applied to both control and projection runs

# *Participant RCMs in RMIP III*

1. Institute of Atmospheric Physics/CAS, China
2. National Climate Center/CMA, China
3. Nanjing University, China
4. Seoul National University, Korea
5. Metrological Research Institute/JMA, Japan
6. CSIRO/CCAM, Australia, Commonwealth Scientific and Industrial Research Organization
7. Yonsei University, Korea
8. Hawaii University, USA
9. National Research Institute for Earth Science and Disaster Prevention, Japan

*Thank you!*