



CEOP/Semi-arid Region Study (SRS)

- recent activities

**Congbin FU, Weidong GUO
and many other contributors**

20 Aug., 2009

Why semi-arid region?

- The region, most vulnerable due to dry climate, low vegetation cover and nutrition content and low capacity of the water conservation;
- A transitional zone, most sensitive in response to both human perturbation and climate change.
- e.g. significant aridity trend and increasing dust storms due to both land use and climate variation, with potential impacts on the hydrological cycle, as well as climate.
- A region having less knowledge in land surface process and their modeling.

Proposed overall objectives of CEOP Semi-arid Region Study

Contributions to understanding the water and energy cycles of semi-arid regions and their role in climate system

by globally integrated analysis of CEOP reference sites data, satellite observations and the model outputs

Assist in better prediction of climate and water resources and their management in semi-arid regions where the shortage of water supply is crucial

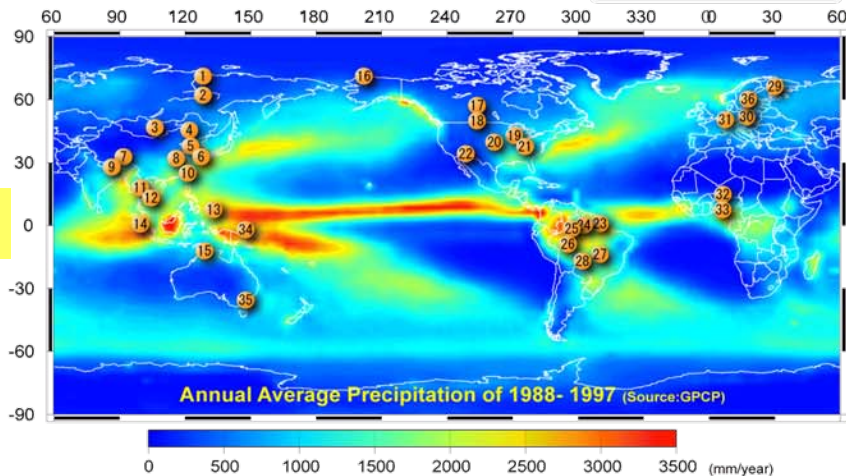
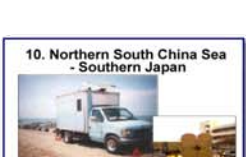
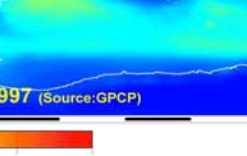
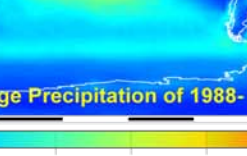
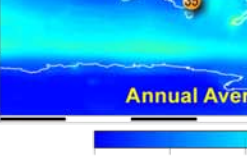
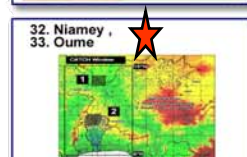
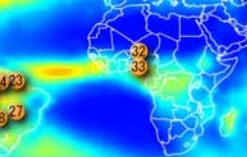
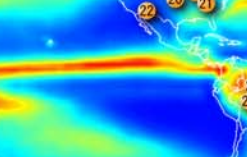
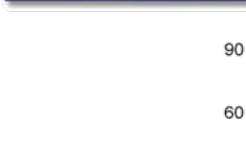
Research Agenda

- **Atmospheric boundary layer physics and dynamics of semi-arid regions;**
- **Water and energy cycle of air-soil-vegetation system in semi-arid regions;**
- **Improvement of parameterization of land surface process for semi-arid region to be coupled in climate models;**
- **Impacts of dust aerosols on hydrological cycle and climate at regional and global scales.**



Potential reference sites for Semi-arid CEOP study

International Cooperation for the Global Coverage

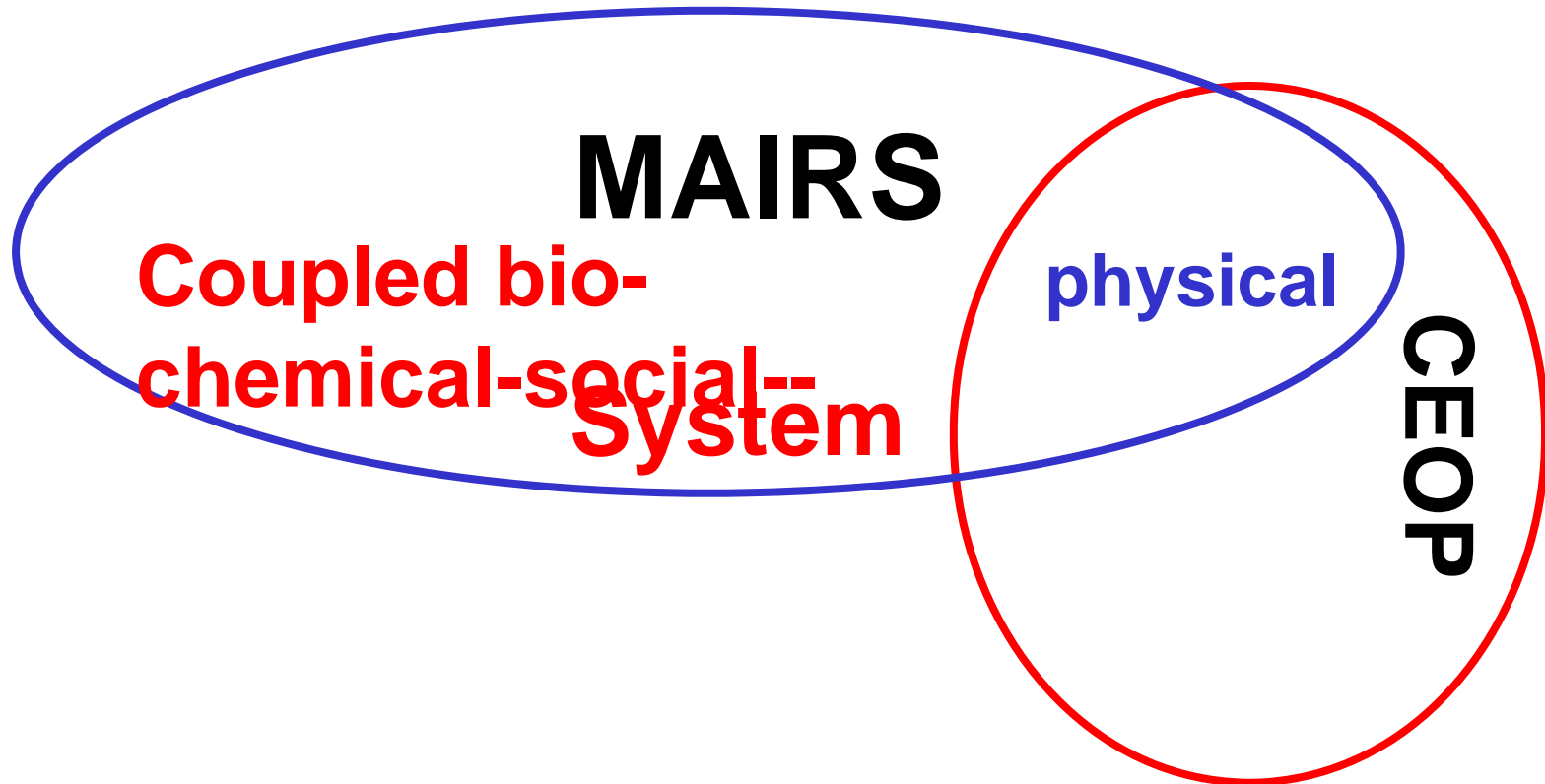


Tongyu

Major activities last year

- ◆ **Mergence of CEOP and MAIRS semi-arid studies;**
- ◆ **International Dryland Workshop, Changchun, China, 23-25 July, 2009;**
- ◆ **Kick-off of the Sino-US joint research project “A Comparative Study on the Interactions between Atmosphere-Land-Water in the Semi-arid Regions of Asia and North America”;**
- ◆ **An initiative and pilot experiment of coordinated observation in arid/semi-arid regions of China (2008, 2009);**
- ◆ **Collaborated studies with CEOP elements...**

Mergence of CEOP and MAIRS semi-arid studies



◆ **International Dryland Workshop,
Changchun, China, 23-25 July, 2009;**

The 2nd MAIRS/CEOP-SRS International Workshop on Dryland Study

Co-organized by: MAIRS, CEOP/SRS

Co-sponsors: CAS, MOST, NSFC

July 23-26, 2009, Changchun, Jilin, China

Key issues discussed :

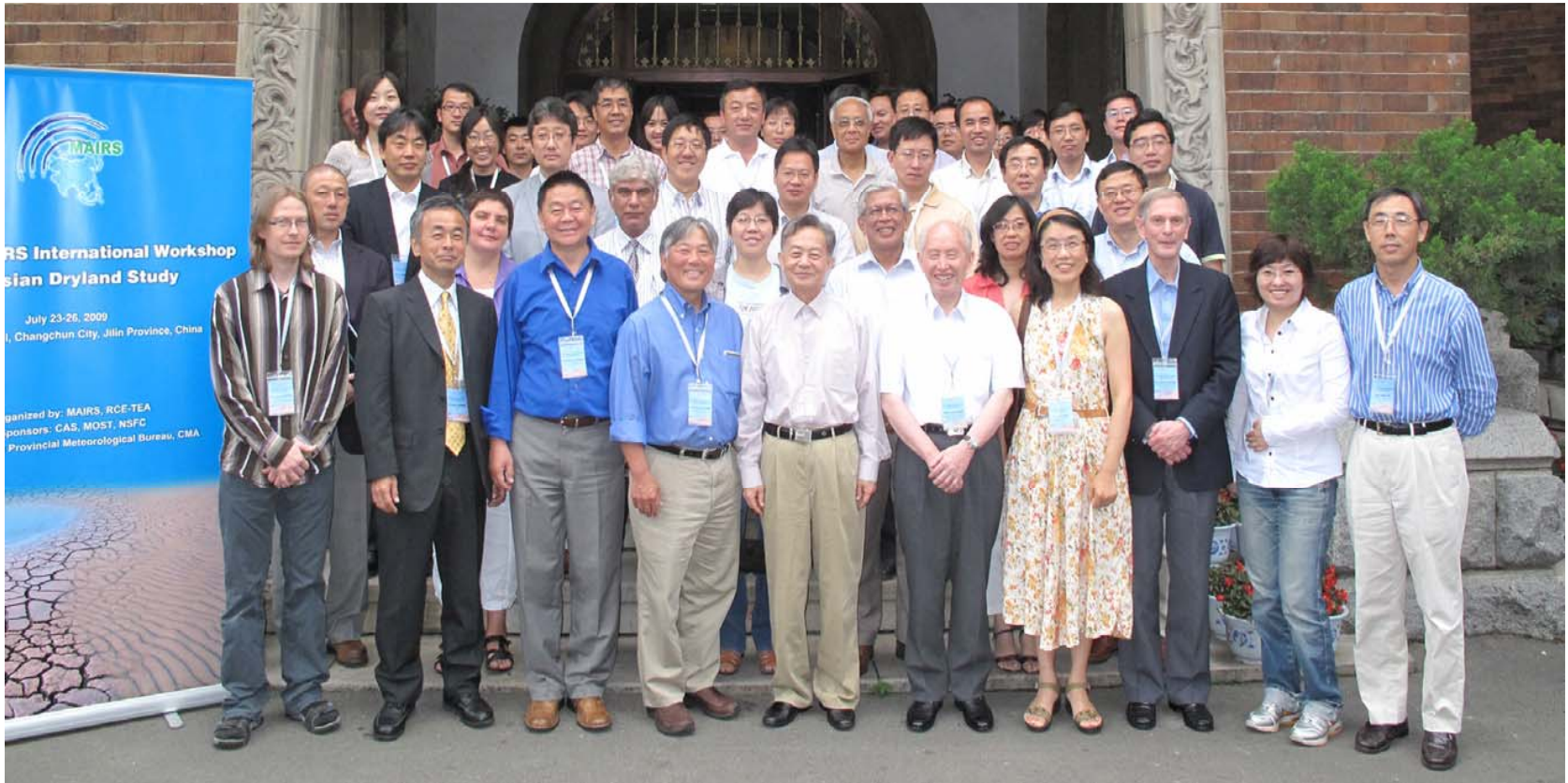
- observation and data quality control
- land surface processes
- dryland hydrological cycle
- data assimilation and regional climate modeling
- dust aerosol and regional climate
- climate change impacts on dryland and adaptation/mitigation strategies.

Scientific Committee:

Prof. Congbin Fu (Chair)
Institute of Atmospheric Physics,
Chinese Academy of Sciences
E-mail: fcb@tea.ac.cn

Local Host:

**Local Host: Jilin Provincial
Meteorological Bureau, CMA**



Over 40 scientists from Asia, Aus., US and EU attended the workshop.



Meeting room at Tongyu station

Climate, scientific issues, instruments, managements...



Field investigation at Tongyu station...



- ◆ **Kick-off of the Sino-US joint research project “A Comparative Study on the Interactions of Atmosphere-Land-Water in the Semi-arid Regions of Asia and North America”;**



Sino-US joint research project

“A Comparative Study on the Interactions of Atmosphere-Land-Water in the Semi-arid Regions of Asia and North America”

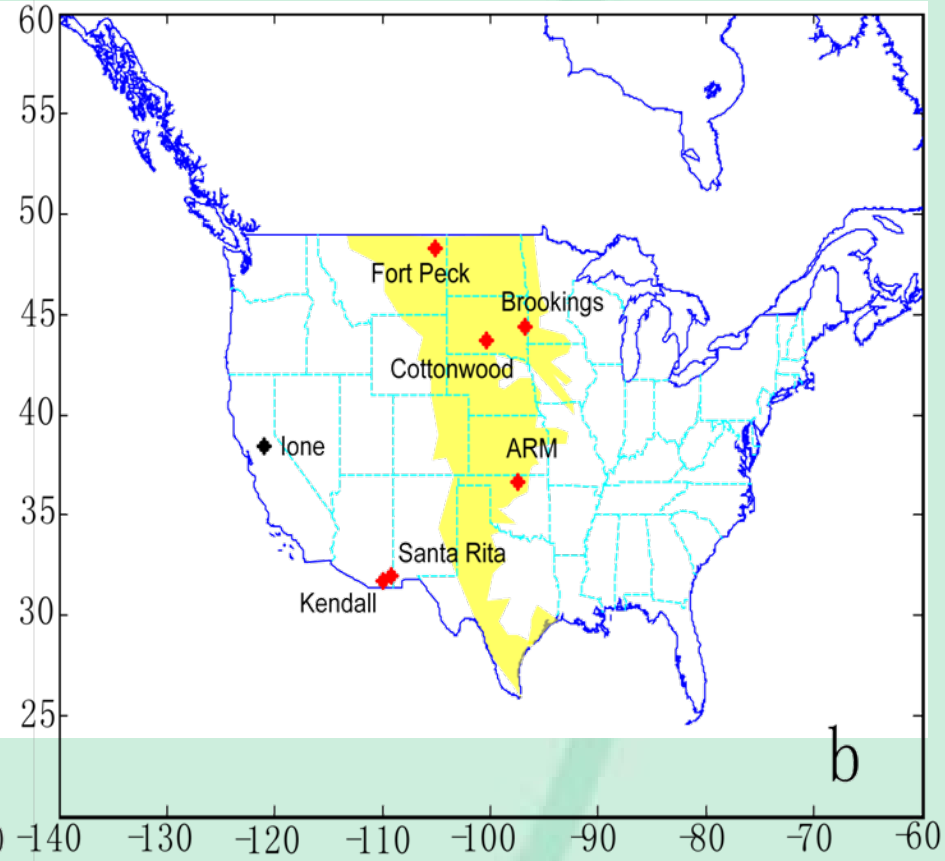
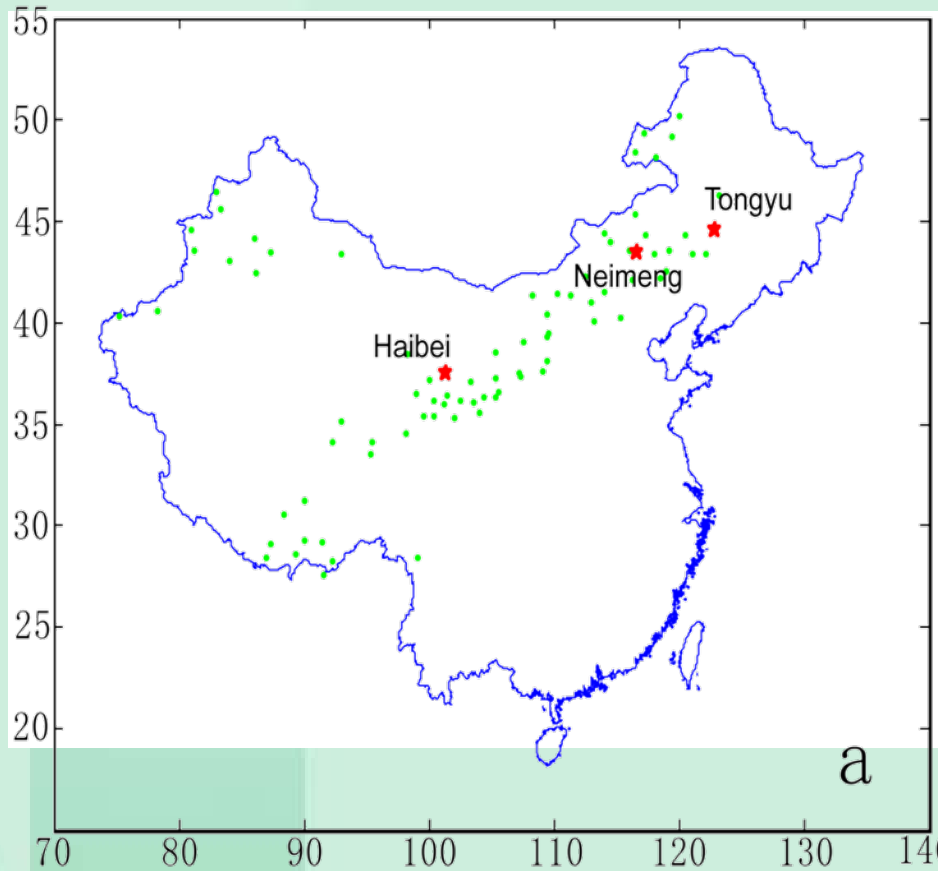
✓ The project is jointly led by Prof. Congbin Fu in Chinese and Prof. Robert E. Dickinson in the US side with participation of 9 Chinese and 6 US members.

✓ The research period of the project is from January 2009 to December 2011.



Prof. Jie SONG (*Northern Illinois Uni., USA*):
Modeling impacts of land use change and agricultural
management on soil carbon

The location of the sites in China and the US

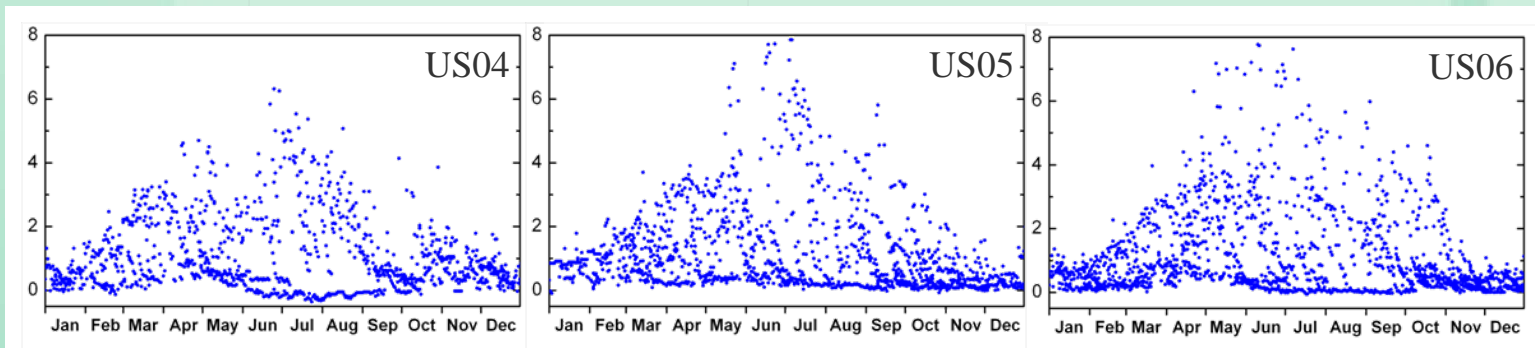
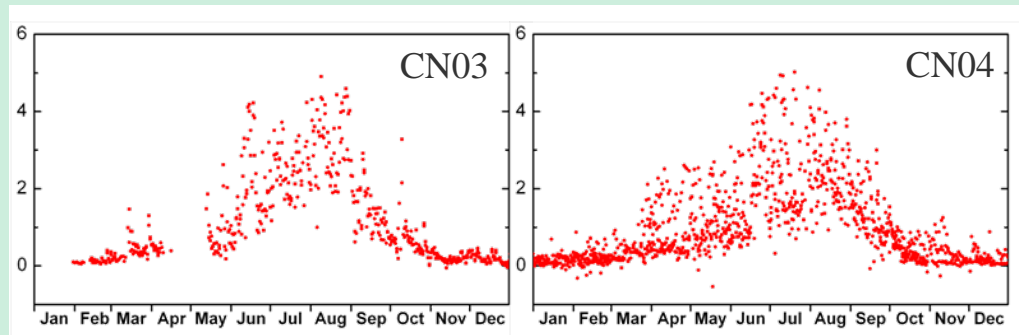


The basic condition of the reference sites

Site	Altitude (m)	Location	Cover	Canopy (m)	Rain (mm)	Data
Tongyu_G	184	44.42, 122.87	Grassland	< 0.1	404.3	2002/10/01 - 2006/12/31
Tongyu_C	184	44.42, 122.87	Cropland	0 – 1.2	404.3	2002/10/01 - 2006/12/31
Neimeng	1187	43.55, 116.68	Grassland	0.5 – 0.6	350 - 450	2004/01/01 - 2004/12/31
Haibei	~3400	37.5, -101.4	Grassland		580	2004/01/01 - 2004/12/31
Fort Peck	634	48.31, -105.10	Grassland	0.2 – 0.4	~ 500	2004/01/01 - 2007/12/31
Brookings	510	44.35, -96.84	Grassland	0.2 – 0.4	~ 600	2004/04/09 - 2007/12/31
Cottonwood	744	41.16, -96.47	Grassland	0.2 – 0.4		2006/11/14 - 2007/12/31
Ione	129	38.41, -120.95	Grassland	< 0.67	229 - 494	2004/01/01 - 2007/12/31
ARM	314	36.61, -97.49	Cropland	0 – 0.5	552 - 901	2004/01/01 - 2007/12/31
Santa Rita	1120	31.82, -110.87	Cropland	2.5	330	2004/01/01 - 2007/12/31
Kendall	356	31.74, -109.94	Grassland	0.5	356	2004/05/06 - 2007/12/31

Actual evaporation: $EP = LE / (2.5008 - 0.002374 * Ta) \cdot 10^{-6}$

Potential transpiration: ET Use FAO Penman-Monteith equations

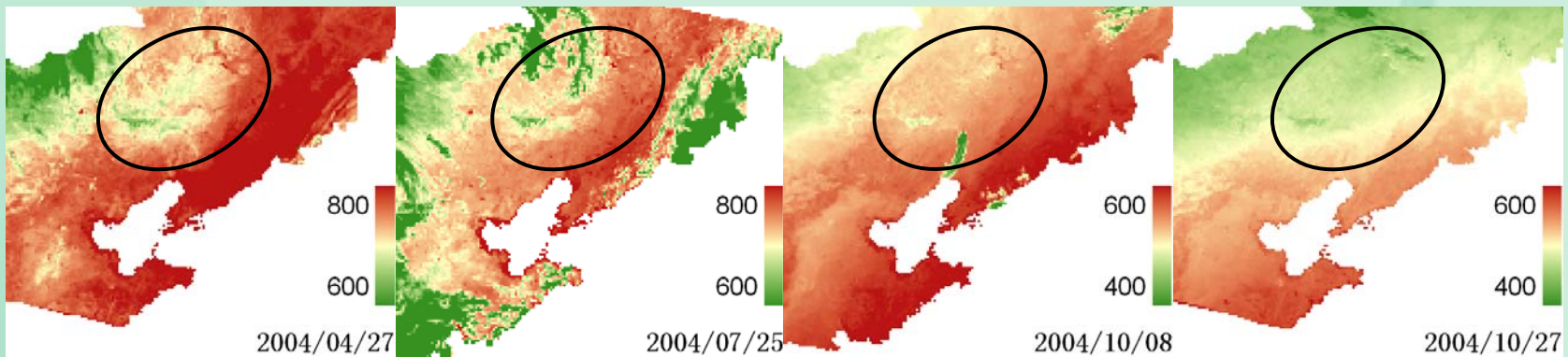
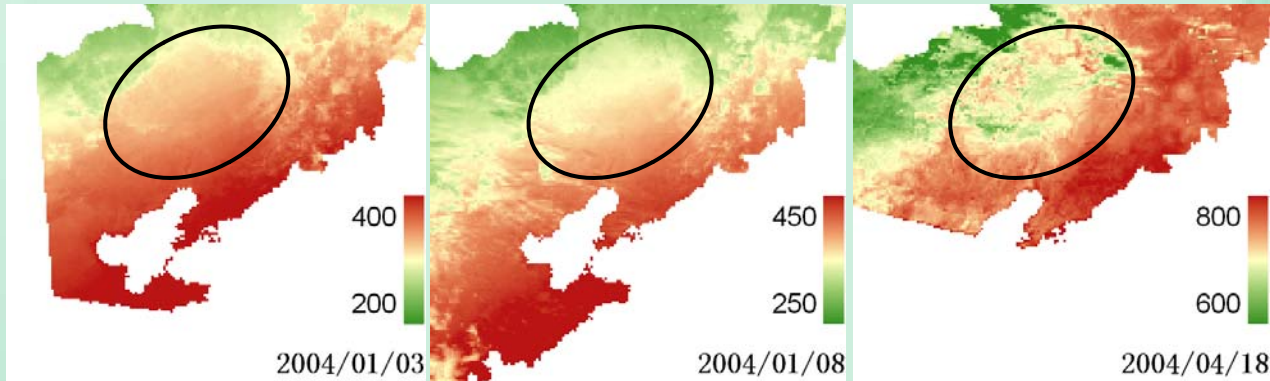


The Actual Evaporation (EP) daily variations

The red maps are the sites in china(year2003, year2004)
The blue ones are the sites in North America(year2004, year2005, Year2006)

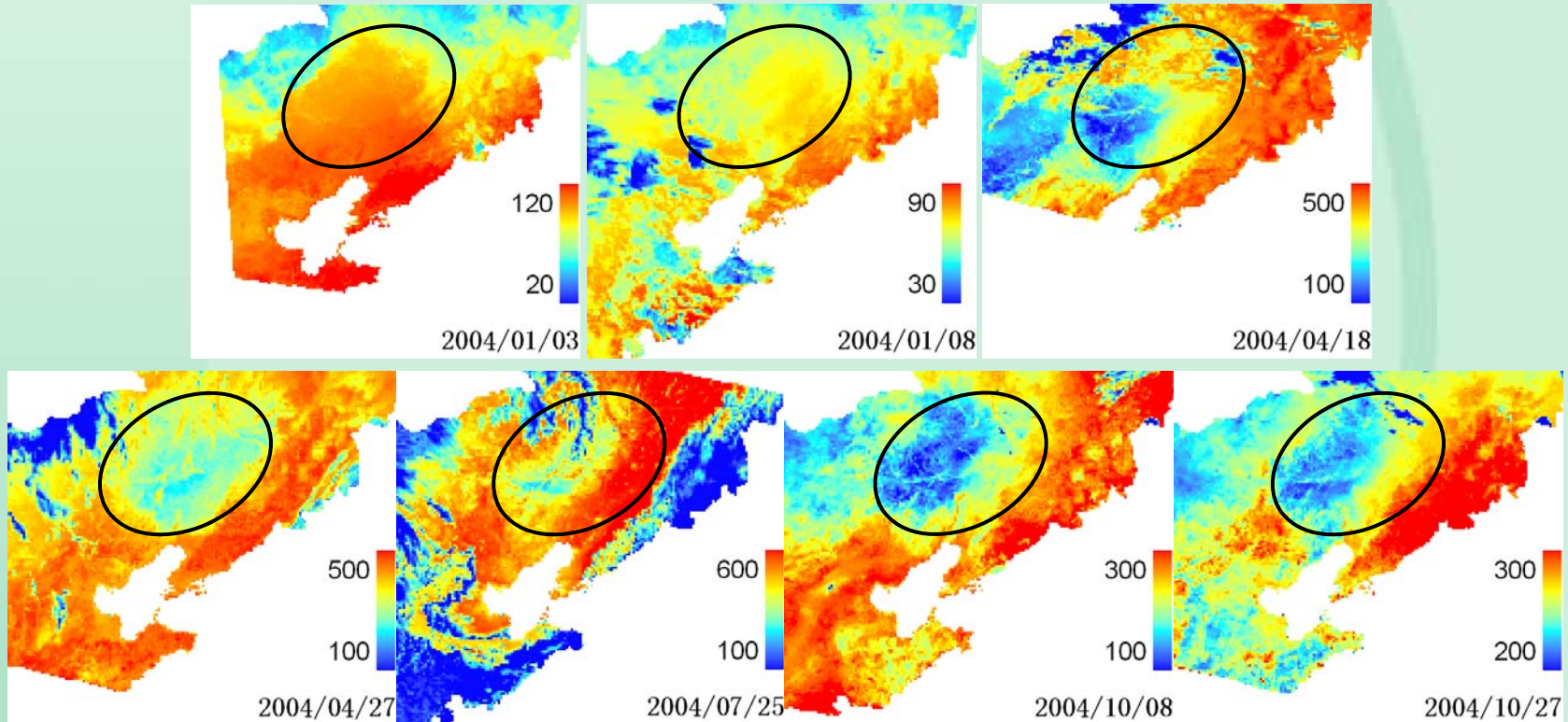
Modis Remote Sensing Estimation

Net Radiation

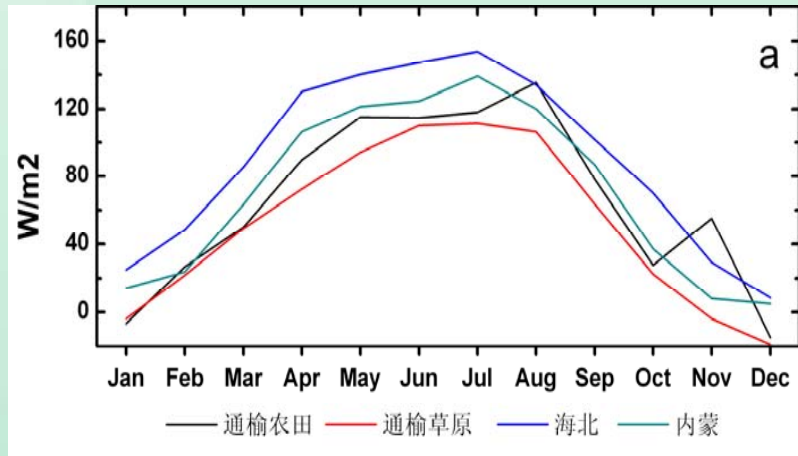


Modis Remote Sensing Estimation

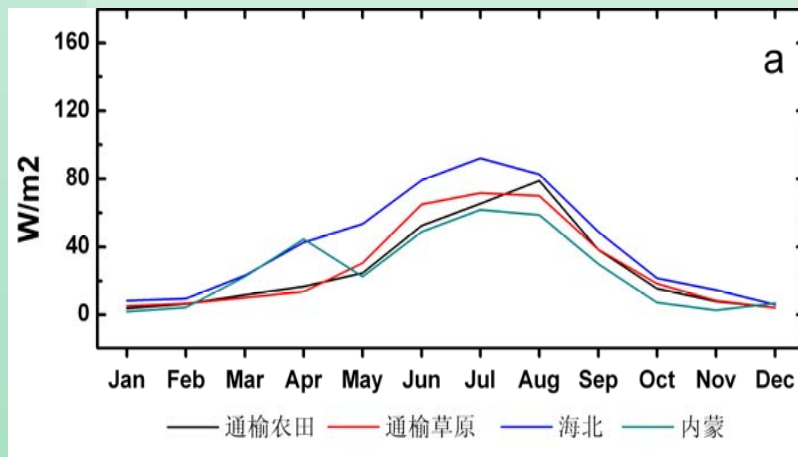
Latent Heat Flux



Observation Data Seasonal Variation



Net Radiation



Latent Heat Flux

Planned activities in 2010...

- ◆ A joint workshop to be hosted in the U.S. Argonne National Laboratory in June 2010.

Topics: comparative studies of energy budget and water cycle; development of land process scheme in semi-arid region; interaction between land surface-vegetation-atmosphere, and feedback of aerosol-cloud- precipitation.

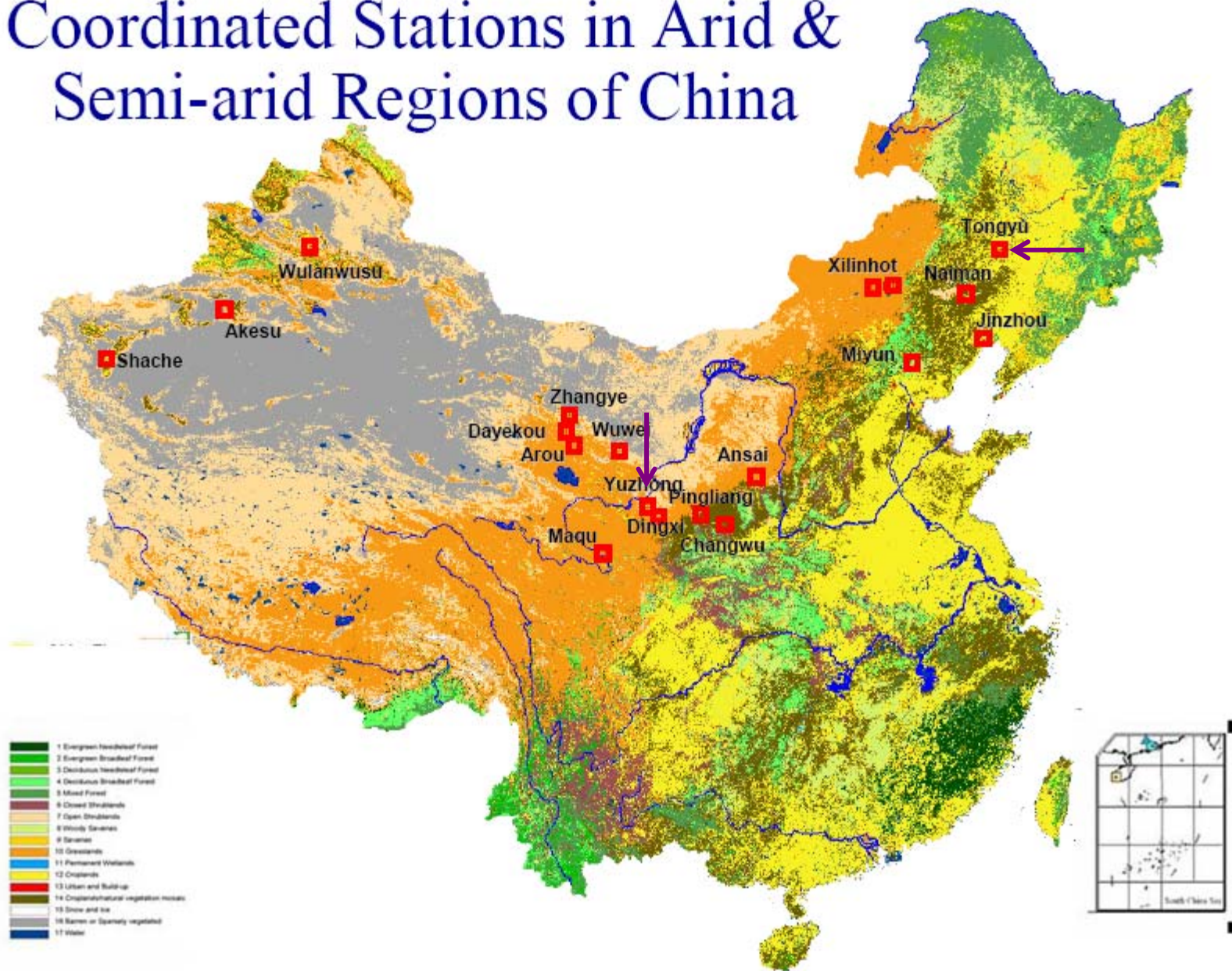
- ◆ Visit a couple of field stations owned by the Argonne National Laboratory, Nebraska University, and Arizona University.

- ◆ **An initiative and pilot experiment of coordinated observation in arid/semi-arid regions of China (2008, 2009);**

Key Science Questions

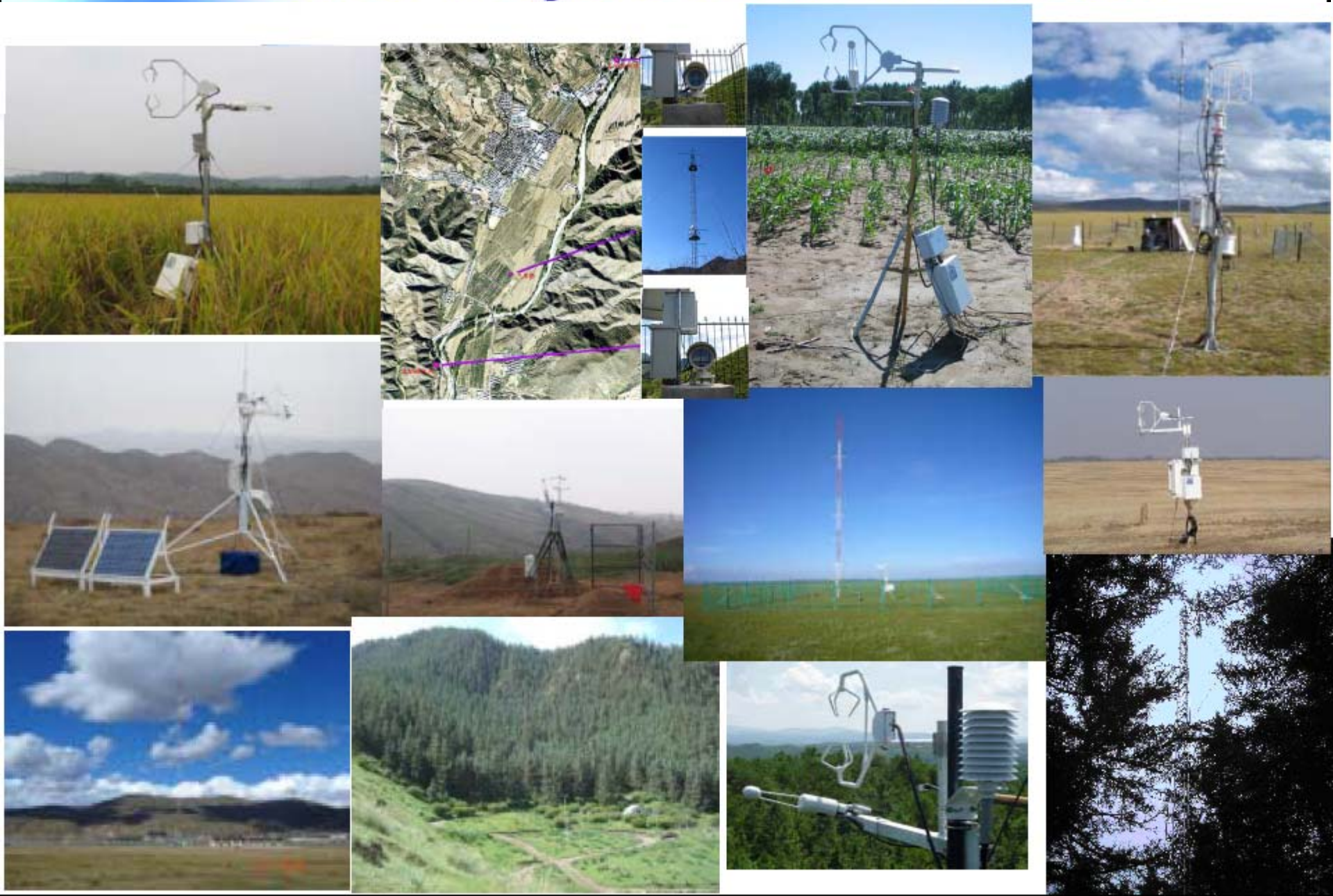
- ◆ What are the important characteristics of land–atmosphere interactions over arid and semi-arid regions in China?
- ◆ What are the fundamental relationships between processes at local and regional scales?
- ◆ What are the relative roles of land use/land cover change (LULC) in controlling North China droughts and other environmental problems?

Coordinated Stations in Arid & Semi-arid Regions of China



	Precipitation Surface Pressure	Wind, temp. & humidity profiles	Radiation components	Energy, H ₂ O & CO ₂ fluxes	Soil temp. & moisture	Ecology	Aerosol
Dingxi	✓	✓	✓	✓	✓	✓	✗
Pingliang	✓	✓	✓	✓	✓	✗	✗
Shache	✓	✓			✓		
Wulanwusu	✓	✓			✓		
Akesu	✓	✓	✓	✓	✓	✗	✗
Changwu	✓	✓	✓	✓	✓	✗	✗
Ansai	✓	✓	✓	✗	✓	✗	✗
Guantan	✓	✓	✓	✓	✓	✗	✗
Miyun	✓	✓	✓	✓	✓		
Xilinhot	✓	✓	✓	✓	✓	✗	✓
Naiman	✓	✓	✓	✗	✓	✓	✗
Xilin	✓	✓	✓	✓	✓	✓	✗
Yuzhong	✓	✓	✓	✓	✓	✓	✓
Tongyu	✓	✓	✓	✓	✓	✓	✓
Wuwei	✓	✓	✓	✓	✗	✓	✗
Zhangye	✓	✓	✓	✓	✓	✓	✗
Jinzhou	✓	✓	✓	✓	✓	✓	✗
Maqu	✓	✓	✓	✓	✓	✗	✗
Arou	✓	✓	✓	✓	✓	✗	✗

What do we get from these stations?



Coordination of the flux networks

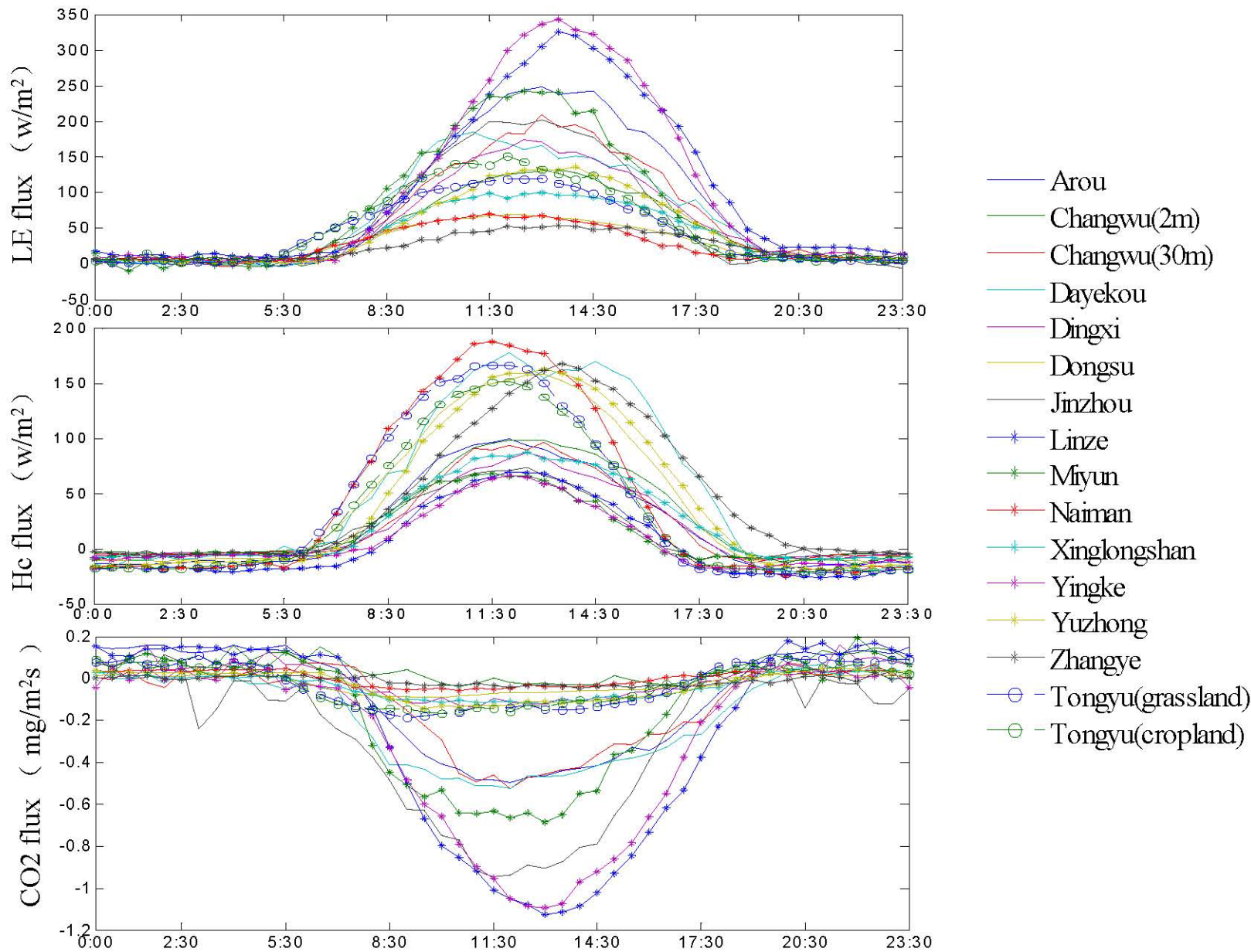
- **Coordination** of various stations, **data exchange & synthetic analysis** are essential issues.
- Quality assurance & data comparability (*accuracy & representability*) are vital for flux networks.
 - **Eddy-covariance flux calculation.** A standard method is necessary for all flux sites.
 - **Data Quality Control / Quality Assurance.** A data assessment system is needed for synthetic analysis.
 - **Flux data Gap-Filling** Interpolate data gaps produced in unfavorable conditions with proper models.
- Especially in difficult conditions...

A coordinated observational study in arid & semi-arid regions of China

- Land surface processes, esp. surface-atmosphere exchanges of energy, H_2O & CO_2 , and related characteristics of ASL on different surface of Arid & semi-arid regions;
- Scaling methods (point observation to regional scale, assimilation & spatial interpolation) in land surface studies of arid & semi-arid areas;
- Parameters ascertainment and parameterization methods in land surface models; comparison study in regional models.

Coordination & Cooperation...

- ✓ **The period of the pilot experiment is from July 1st to September 30th, 2008.**
- ✓ **Before the start of the pilot observation, we had conducted the calibration of Li-7500 sensors for CO₂ and H₂O fluxes measurements at 12 stations and upgraded on-line processing software.**

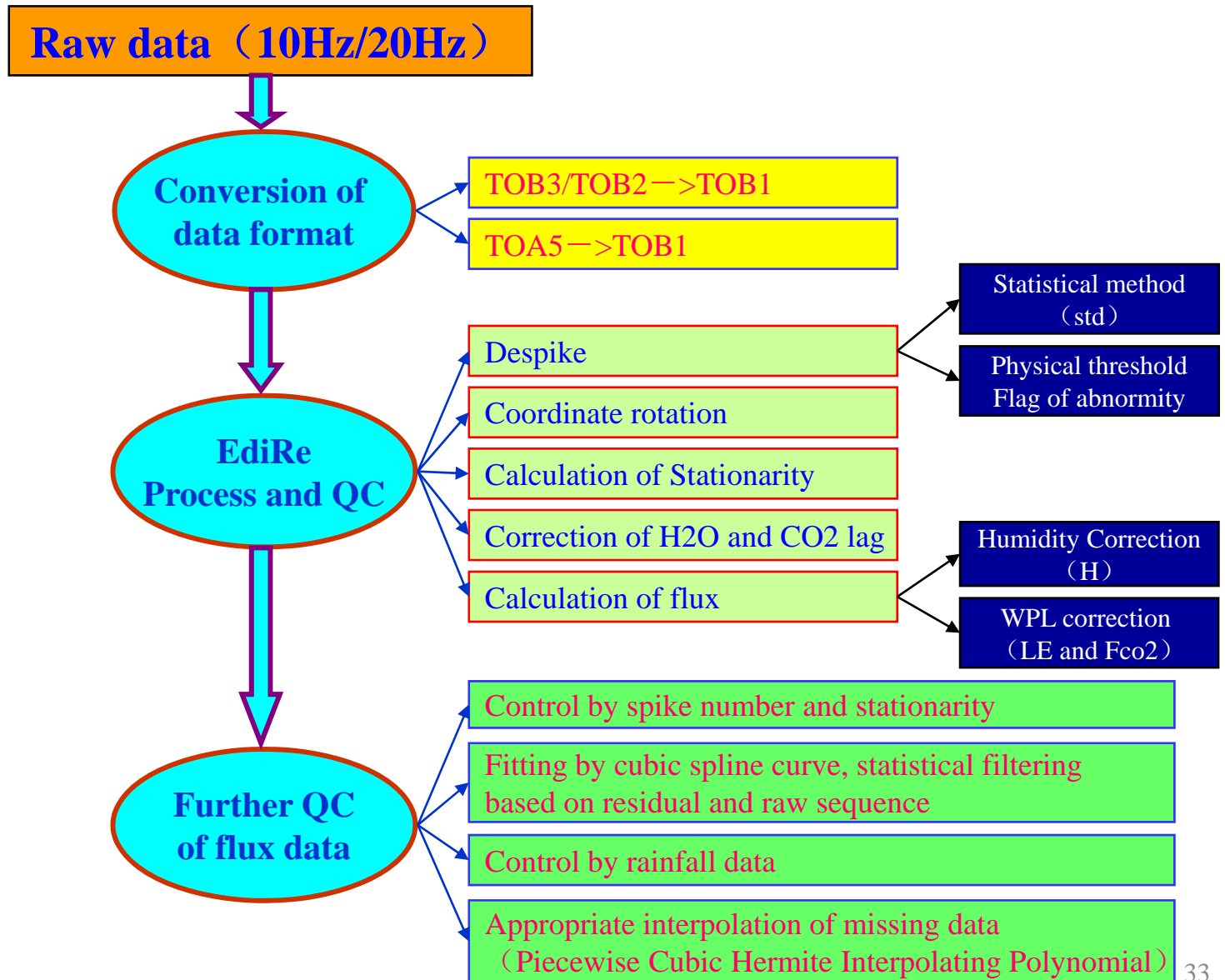


Diurnal Variation of Latent Heat, Sensible Heat and CO₂ Flux in Different Sites

QA/QC of fluxes data...

- ◆ Processing and quality control of EC flux data are very important.
- ◆ Due to the complexity of the issue, the difference of method of processing can cause the bias more than 10%.
- ◆ Normal instruction and recommend of standardized method are scarce in China.

Flow chart for EC flux data process and QC



Step of data processing and quality control

1. Conversion of data format

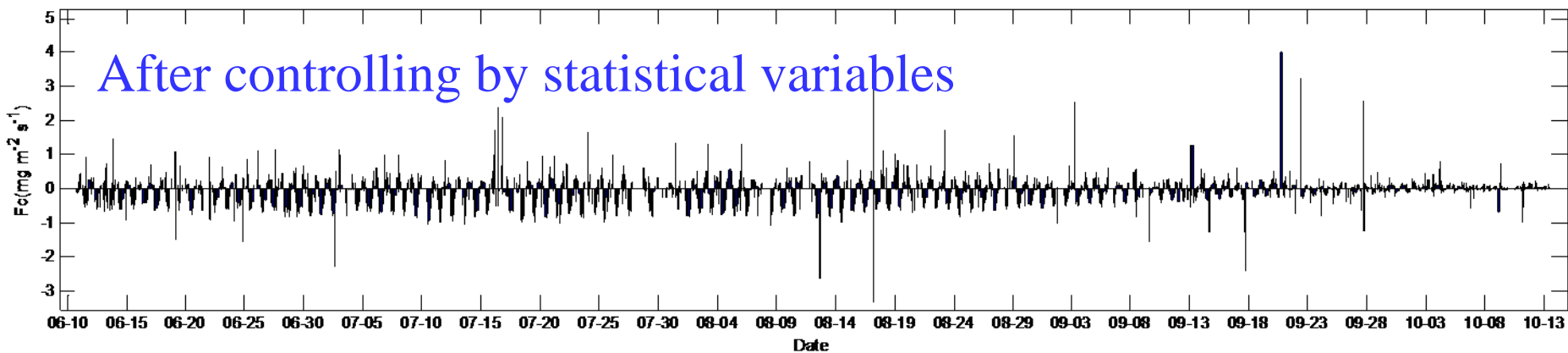
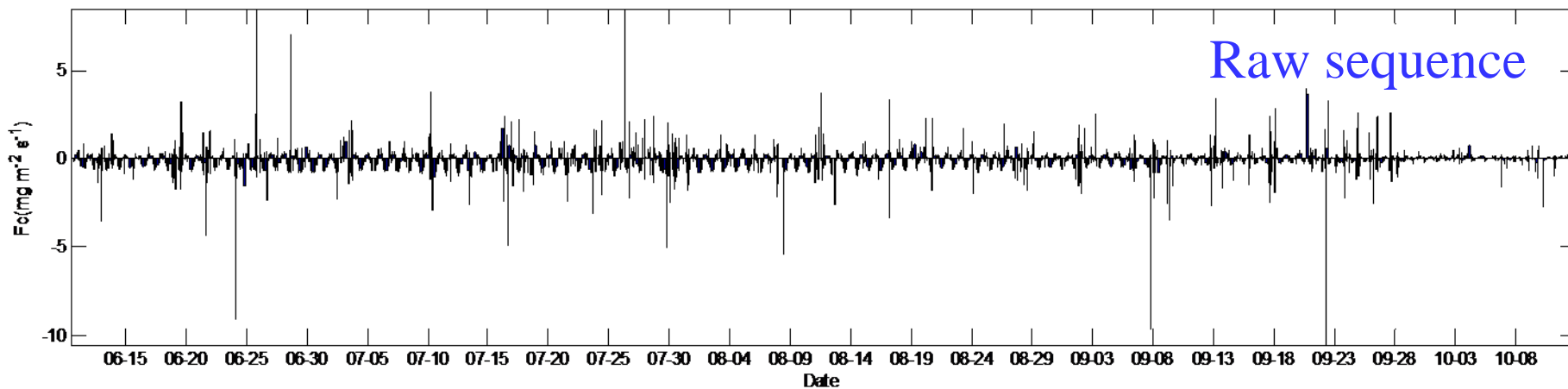
2. Data processing and quality control using EdiRe

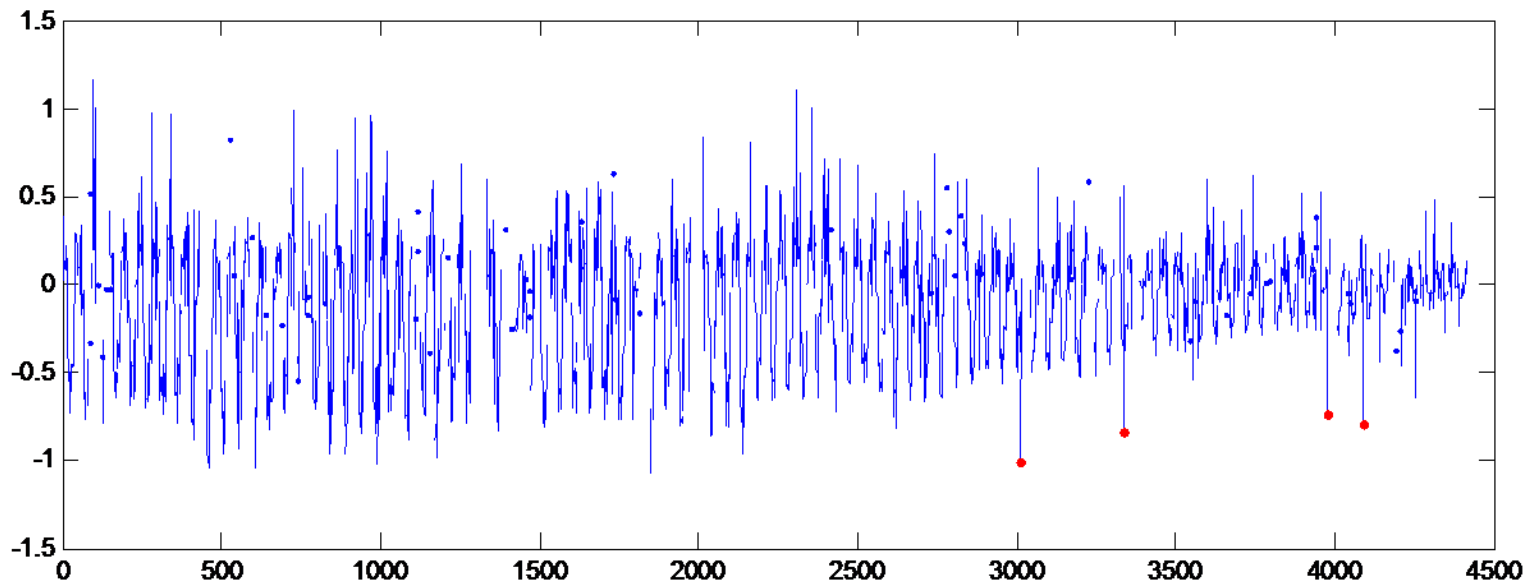
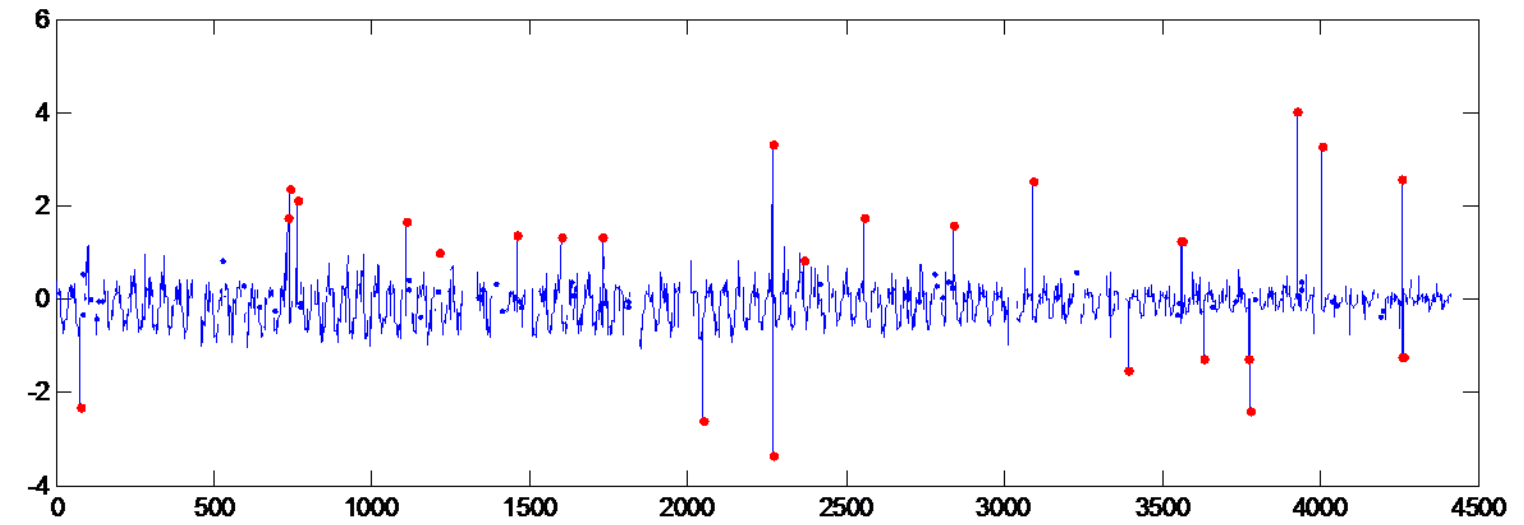
3. Further quality control of flux data

Further quality control of flux data

- ◆ Control by statistical variables
- ◆ Data filtering based on the characteristic of flux data
- ◆ Appropriate interpolation of missing values
- ◆ Impact on flux data by rainfall

Fco2 of Arou station



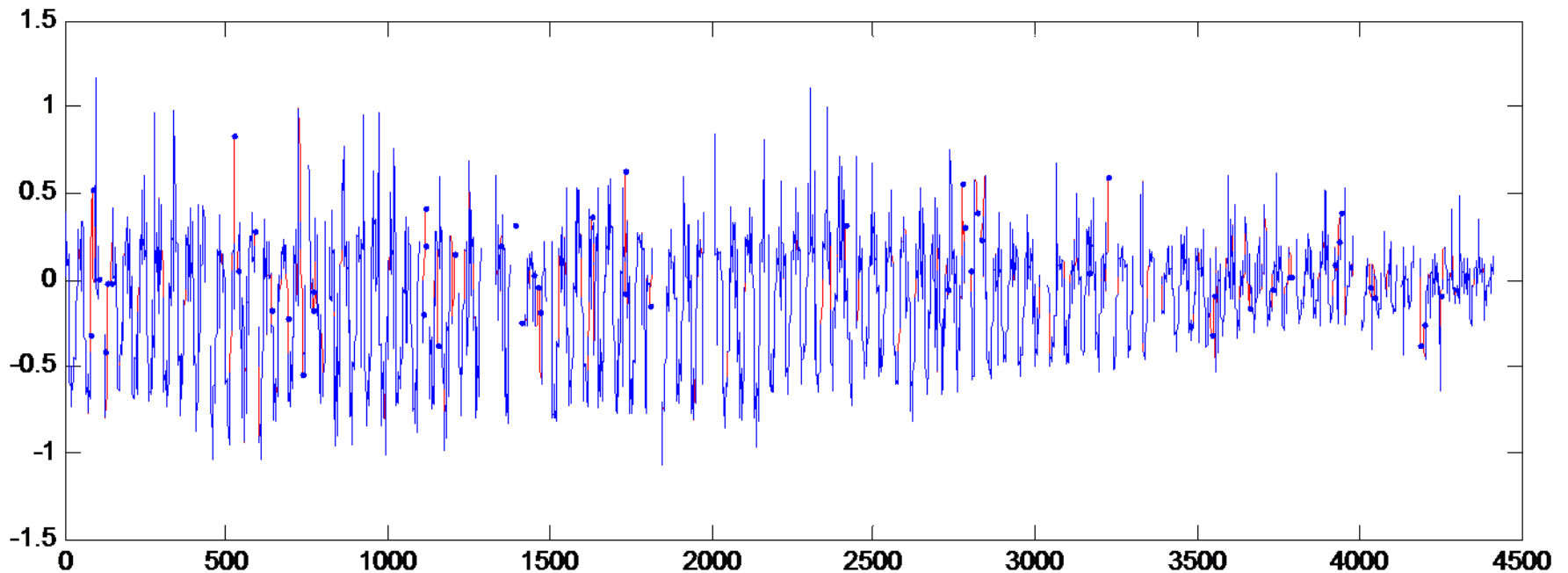


Red symbols mean abnormal points

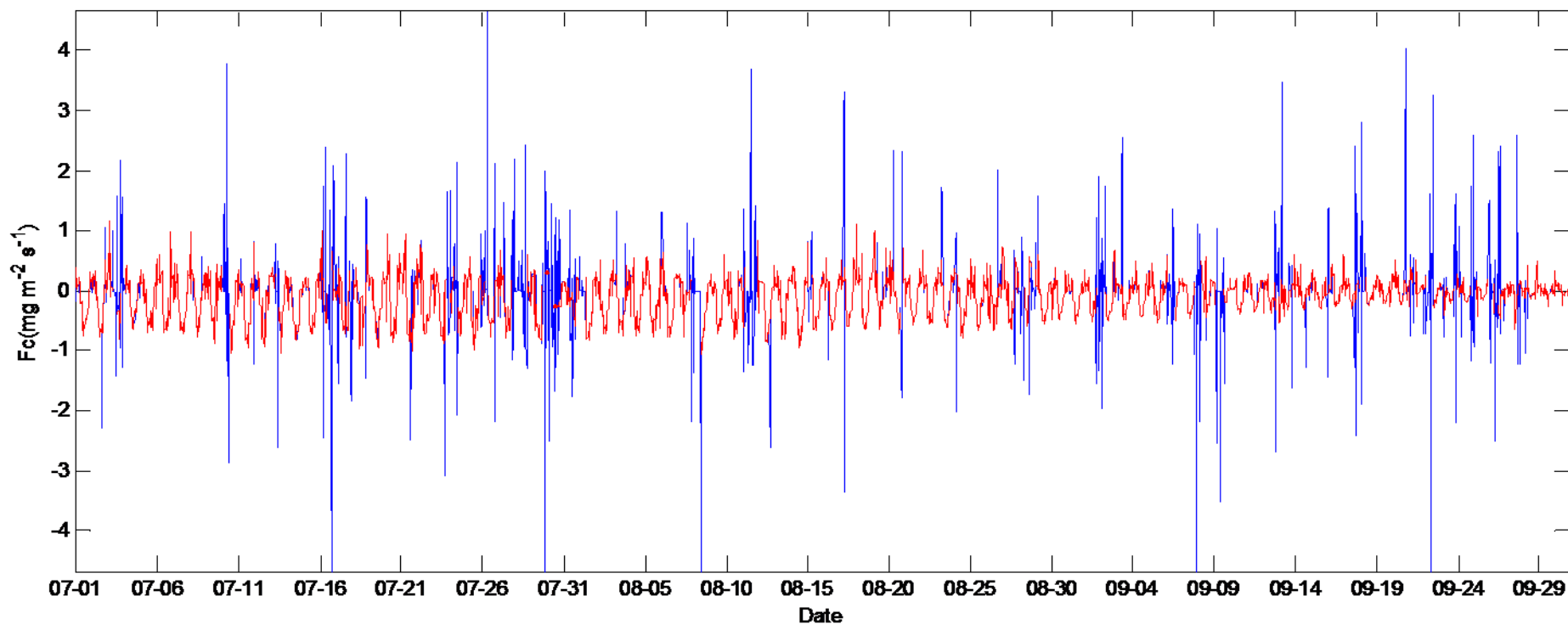
Fco2 of Arou after appropriate interpolation

Blue: raw sequence

Red+Blue denotes new sequence after interpolation

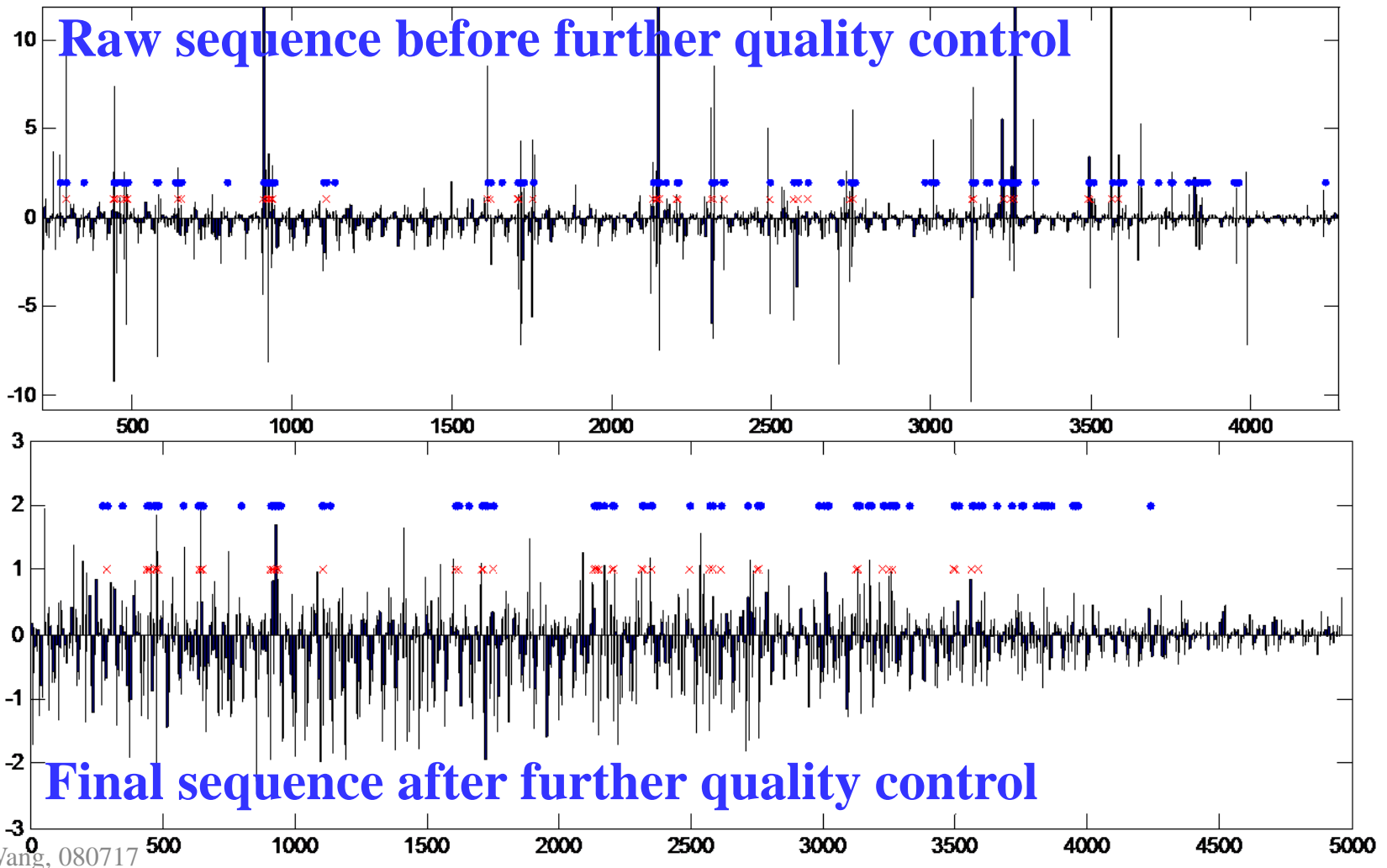


Red: Final sequence after further quality control
Blue: Raw sequence before further quality control



Impact on flux data by rainfall (Fco2 of Miyun station)

(Blue points mean rainfall events; Red symbols mean abnormal flux data)



Share of Pilot experiment Data

- **Flux Data and Bounding Layer Meteorological Data;**
- **Satellite Remote Sensing Data ;**
- **Simulation Results by Regional Environment Model**

http://observation.tea.ac.cn



北方干旱-半干旱地区 协同观测

首页 | 项目简介 | 数据下载 | 数据演示 ▶ ENGLISH

项目介绍

- 项目简介
- 科学目标
- 组织结构
- 数据共享

数据服务

- 数据下载
- 数据演示
- 质量控制
- 应用软件

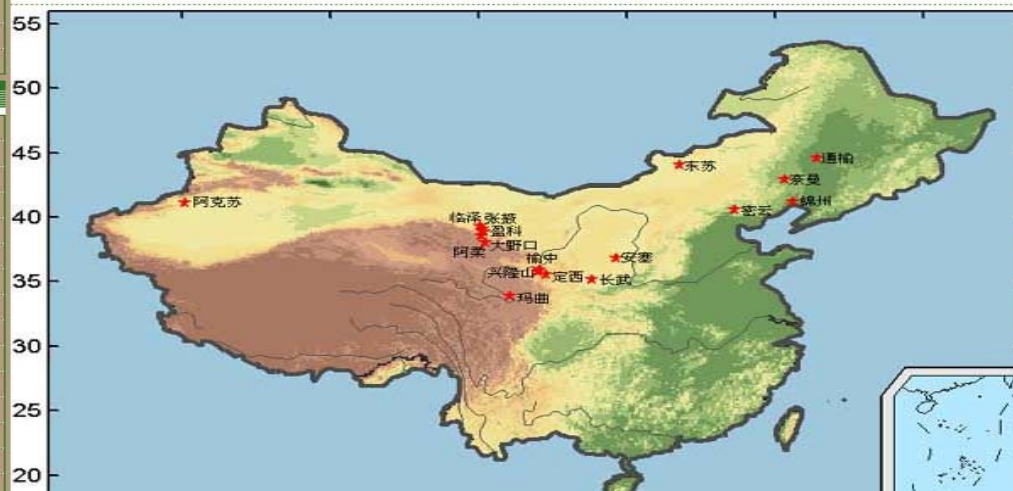
观测台站

- 阿克苏绿洲站
- 阿荣冻融站
- 长武站
- 大野口天然森林站
- 东苏站
- 锦州站
- 临泽内陆河流域站
- 密云站
- 通榆农田站
- 通榆退化草地站
- 兴隆山站
- 榆中站
- 奈曼站
- 盈科站
- 定西站

最新进展

Activities

- ▶ 数据下载 (20080701-20080930) [2009-1-21]
- ▶ 协同观测数据初步分析 [2009-1-21]
- ▶ “干旱半干旱区协同观测预实验数据质量控制培训班” 于2008年7月17-18日在西安召开 [2008-7-23]
- ▶ 台站仪器标定完成 [2008-7-1]
- ▶ 中国干旱/半干旱区多学科协同观测预实验启动会 会议纪要 [2008-5-20]



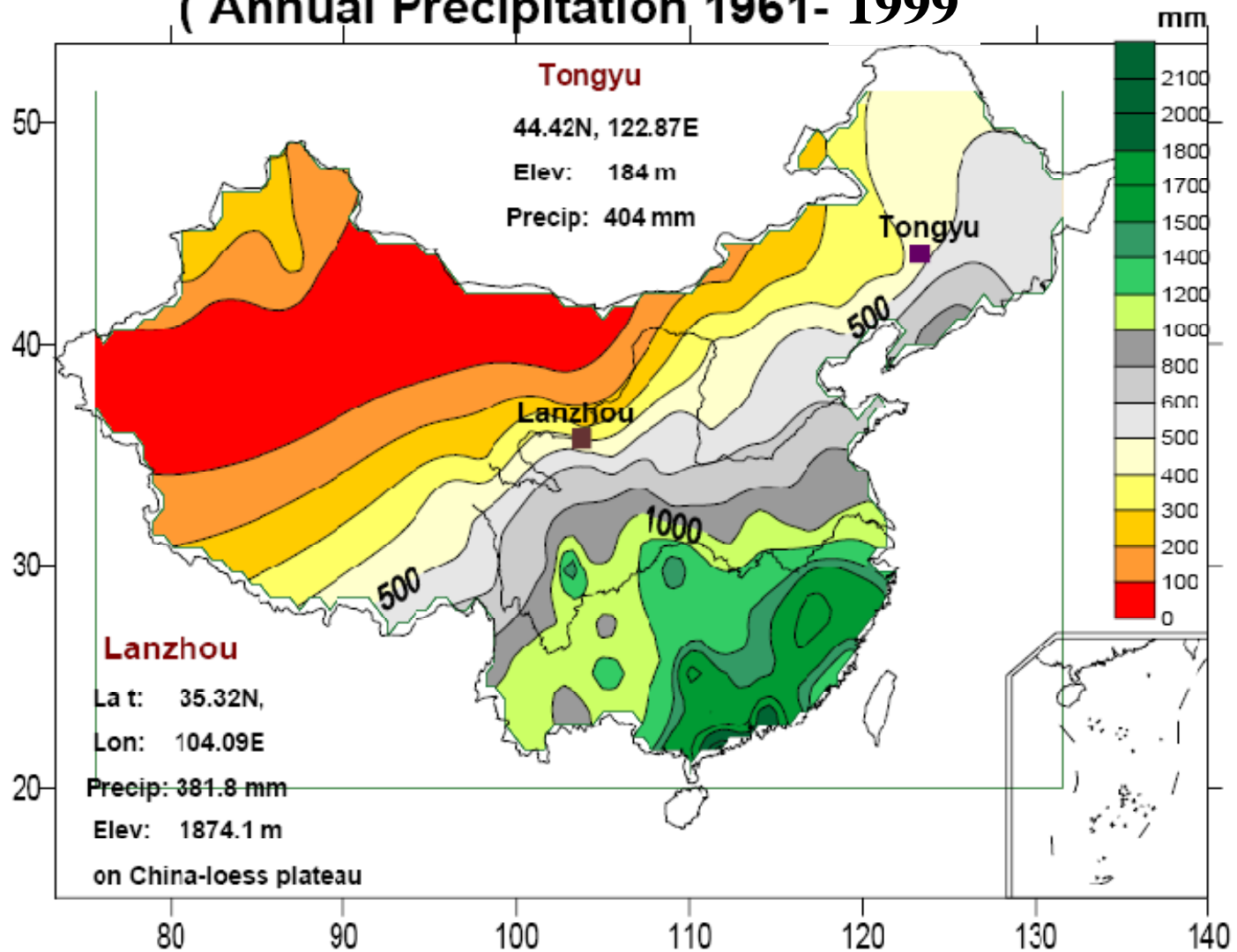
- A wide range of data products have been released to all participants including field observations, products of land surface assimilation and related regional models' output, Satellite data, etc.
- After evaluation of this pilot experiment, this coordinated observation will remain for a longer period.

Continues in 2009, from June 1st to Sept. 30th. The involved stations with fluxes measurements have increased from 14 to 19...

◆ Collaborated studies with CEOP elements...

CEOP Reference site Tongyu and Lanzhou

(Annual Precipitation 1961- 1999



In-situ data:

Tongyu Station (degraded grassland), enhanced observations during EOP3, 4 (1st Jan. 2003—31st Oct., 2004)

8 Numerical models of CEOP:

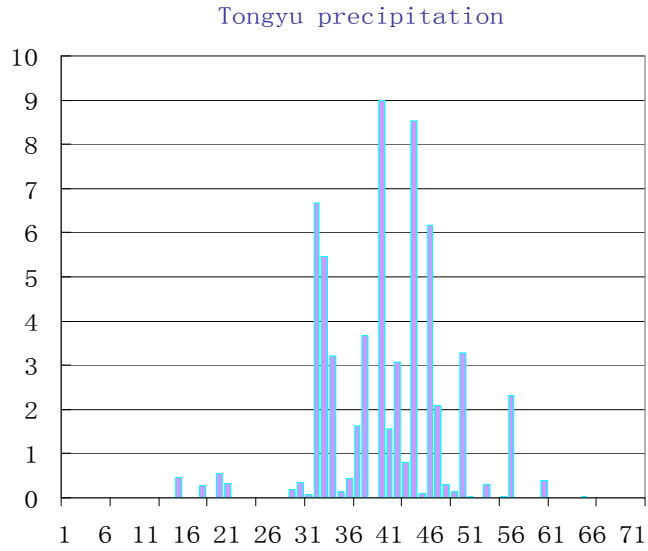
(model grid point corresponding to Tongyu (44.375°N,122.5°E))

- **BMRC (Bureau of Meteorology Research Centre, Australia)**
- **CPTEC (The Center for Weather Forecasts and Climate Studies, Brasil)**
- **ECPC—RII (Experimental Climate Prediction Center (ECPC) – Reanalysis II (RII), U.S.A, with University LSM ver.2)**
- **ECPC—SFM (Experimental Climate Prediction Center (ECPC) –Seasonal Forecast Model (SFM), U.S.A)**
- **JMA (Japan Meteorological Agency, Japan)**
- **MSC (Meteorological Services of Canada, Canada)**
- **Stdd**
- **UKMO (United Kingdom Meteorological Office, United Kingdom)**
- **NCEP (National Centers for Environmental Prediction, U.S.A)**

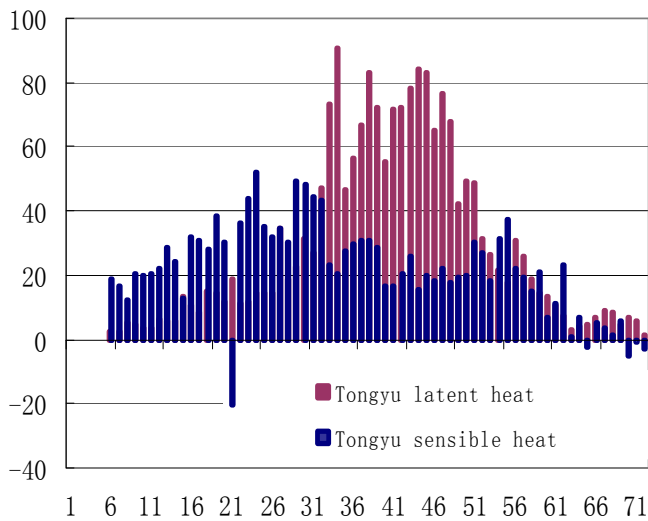
Horizontal resolution: 1.25x1.25, vertical resolution: surface, 2m, 10m, 850hPa, 700hPa, 500hPa, 300hPa, and 200hPa.

From Oct. 2002 to Dec. 2004, every 6h

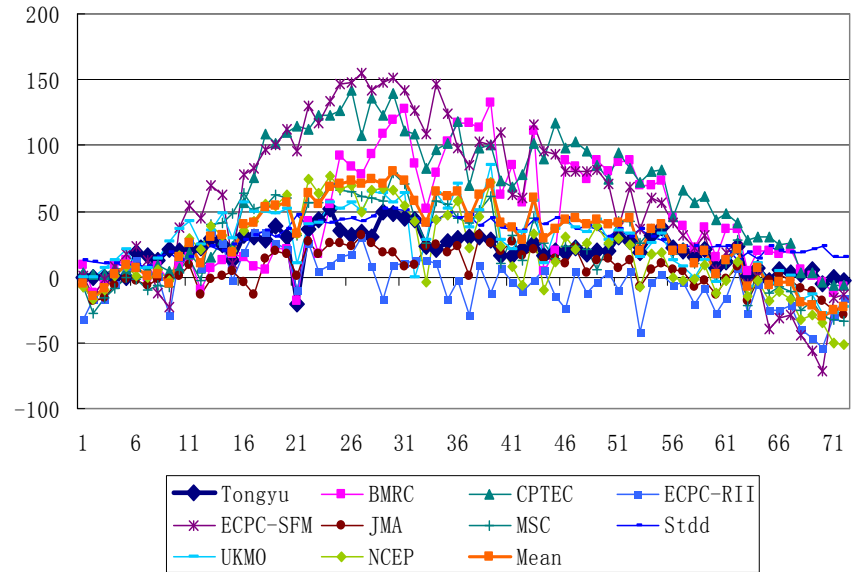
Relation of seasonal variation between heat fluxes and precip. (Tongyu)



Precipitation in 2003 (mm/d)

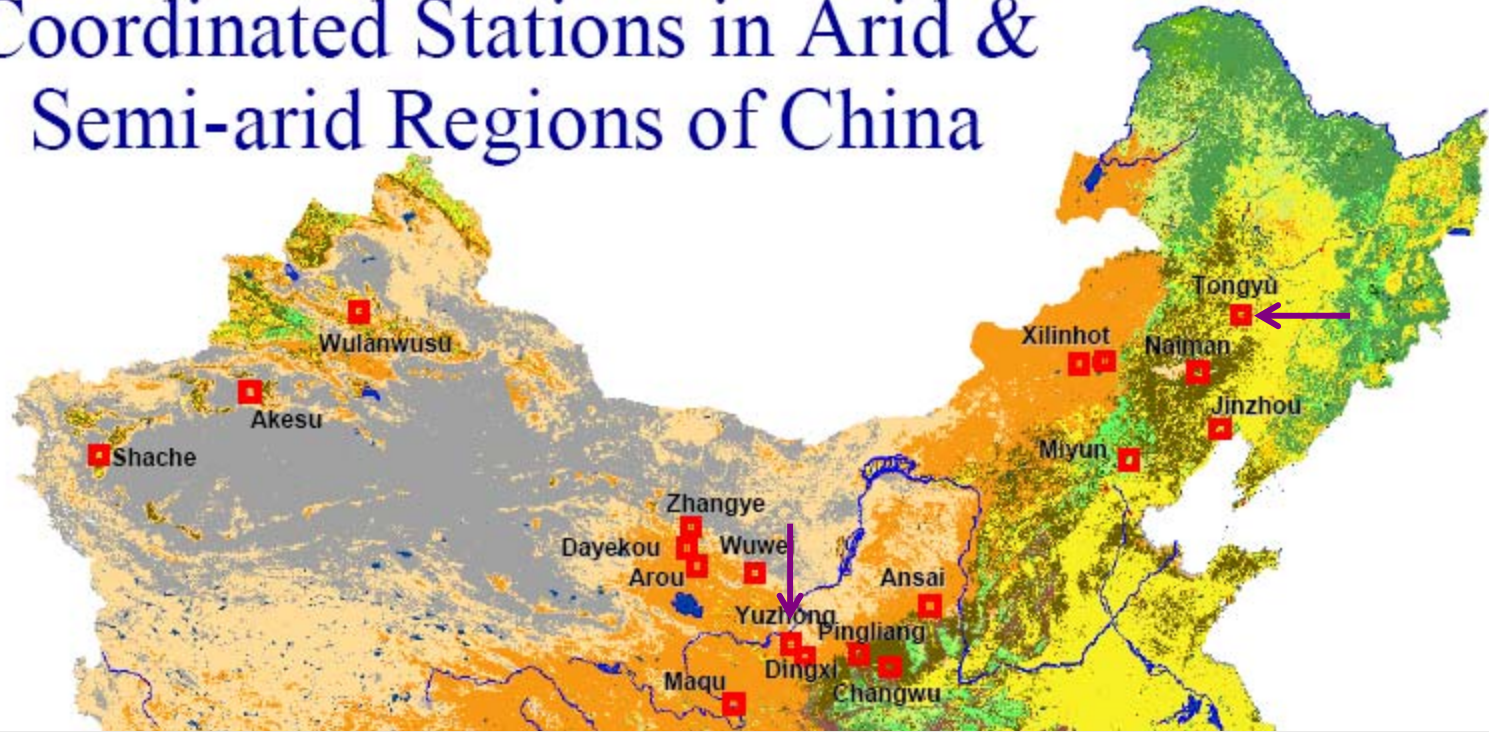


Evolution of sensible/latent heat fluxes
in 2003 (W/m^2)



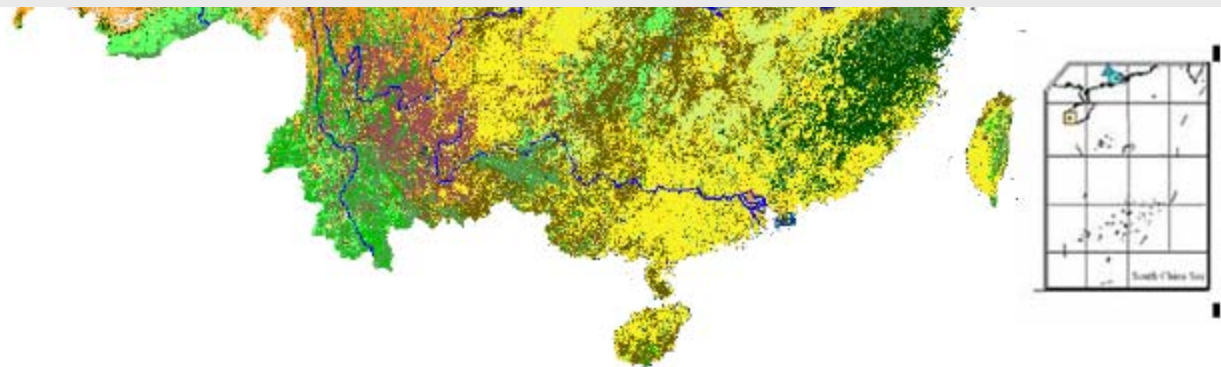
Evolution of sensible (upper)/latent (lower) heat fluxes
in 2003 by model output (W/m^2)

Coordinated Stations in Arid & Semi-arid Regions of China



Evaluating global/regional model outputs in collaboration with CEOP/modeling session based on the coordinated observations...

- 1 Evergreen broadleaf Forest
- 2 Evergreen Broadleaf Forest
- 3 Deciduous broadleaf Forest
- 4 Deciduous Broadleaf Forest
- 5 Mixed Forest
- 6 Closed Shrublands
- 7 Open Shrublands
- 8 Woody Savannas
- 9 Savannas
- 10 Grasslands
- 11 Permanent Wetlands
- 12 Croplands
- 13 Urban and Built-up
- 14 Cropland/vegetation mosaic
- 15 Snow and Ice
- 16 Barren or Sparsely vegetated
- 17 Water



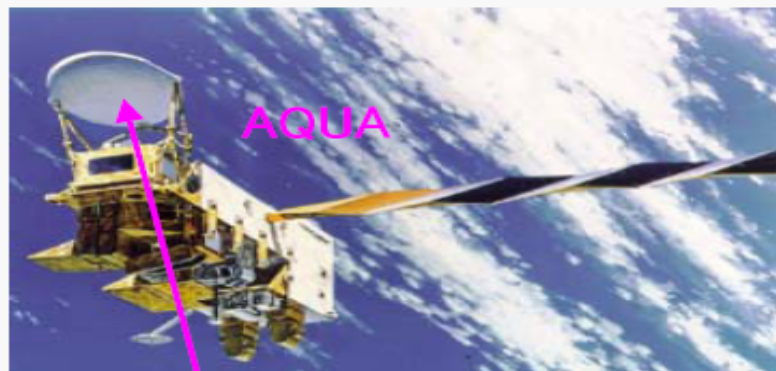


Collaborative studies with CEOP/WEBS...

Soil Moisture Observations by Ground-Based Stations and Satellites in Asia

Ichiro KAIHOTSU (Hiroshima U), Toshio KOIKE (U Tokyo), Hideyuki FUJII (JAXA) and Kazuaki SHIRAISHI (Hiroshima U.)

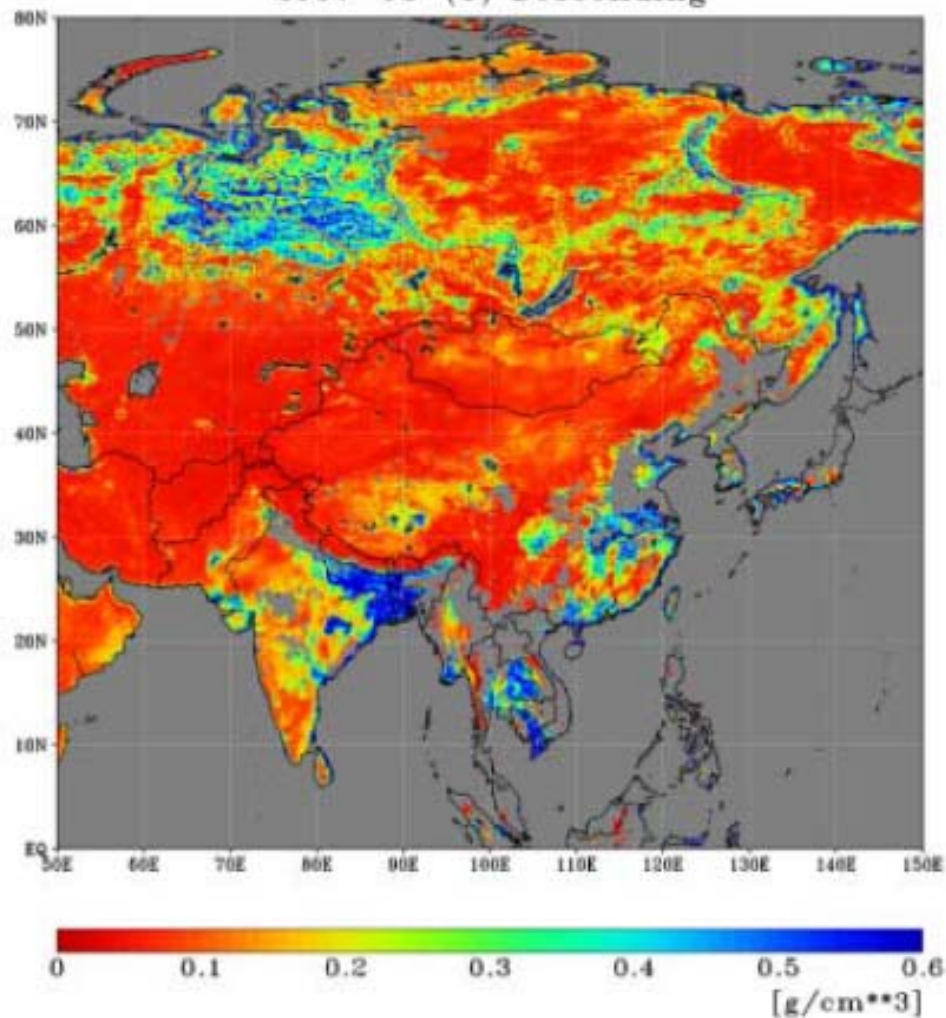
Soil moisture monitoring by AMSR-E (AQUA)



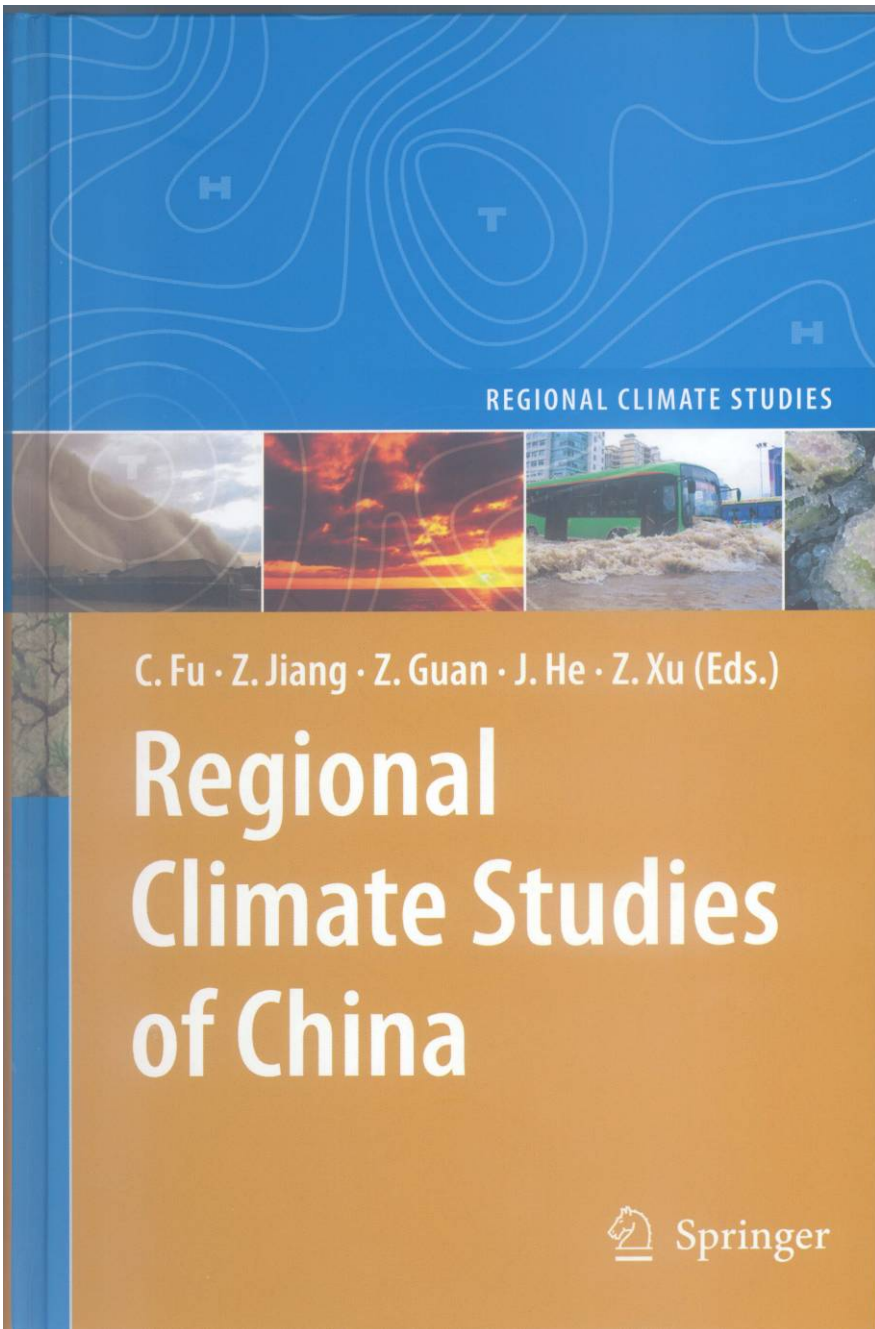
AMSR-E (Advanced Microwave Scanning Radiometer-EOS) of AQUA (EOS Aqua Launch : May 4, 2002): AMSR-E in PM Orbit

Frequency (GHz)	6.9	10.65	18.7	23.8	36.5	89.0
Ground resolution (km)	43	29	16	18	8.2	3.5
Bandwidth (MHz)	350	100	200	400	1000	3000
Polarization	Horizontal and vertical					
Observation swath	1,450 km					
Absolute accuracy	1K(1 σ) target					

Aqua AMSR-E Soil Moisture (Koike V5.22)
2007-08-(3) Descending



Soil moisture estimation by AMSR-E in Asia



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Thank you