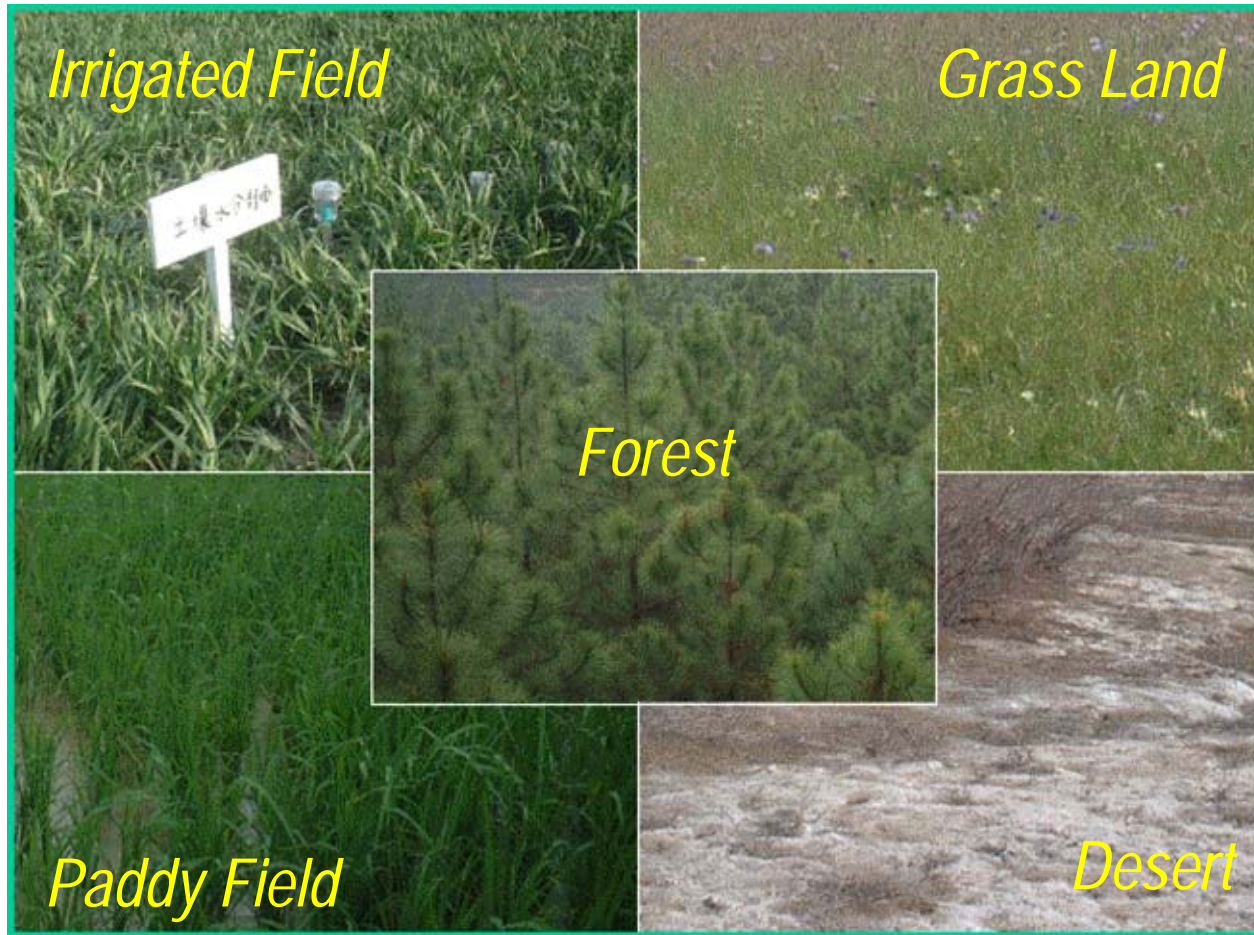


Water, Heat and CO₂ Transfer over Various Ecosystems and MODIS Validation Using APEIS-Flux Data



Qinxue WANG,
Masataka WATANABE,
Seiji HAYASHI,
Shogo MURAKAMI,
**(National Institute for
Environmental Studies,
Japan)**

Zhu OUYANG, Yan LI,
Yingnian LI, Kelin WANG,
Jiyuan LIU
**(Chinese Academy of
Sciences, China)**

Introduction

heat, water and carbon transfer processes

FLUXNET
controlling the exchanges

mechanisms

[www.daac.ornl.gov/
FLUXNET/fluxnet.html](http://www.daac.ornl.gov/FLUXNET/fluxnet.html)

Very Few Sites in China



Objectives

- Establish APIES-FLUX network
- Calibrate MODIS high-order products
- Develop integrated model

Research Flowchart

**APIES-FLUX
Network**

**APEIS-MODIS
Network**

**Meteorological
Data**

DEM

Soil Data

Field LAI

NDVI

1. Respiration
2. Temperature
3. Water content
4. SOM

NDVI-LAI model

Meteorological model

1. Radiation transfer
2. Energy balance
3. Eddy covariance
4. Vapor pressure deficit

C,N-Cycle model
(Biome-BGC)

Land-surface Process
model (SiB2)

Water, Heat and CO₂ Fluxes, NPP, Crop Yield

Crop-growth model (DSSAT)

Planting, Harvesting, Irrigation, Fertilizer Application ...



Field Experiment Strategy

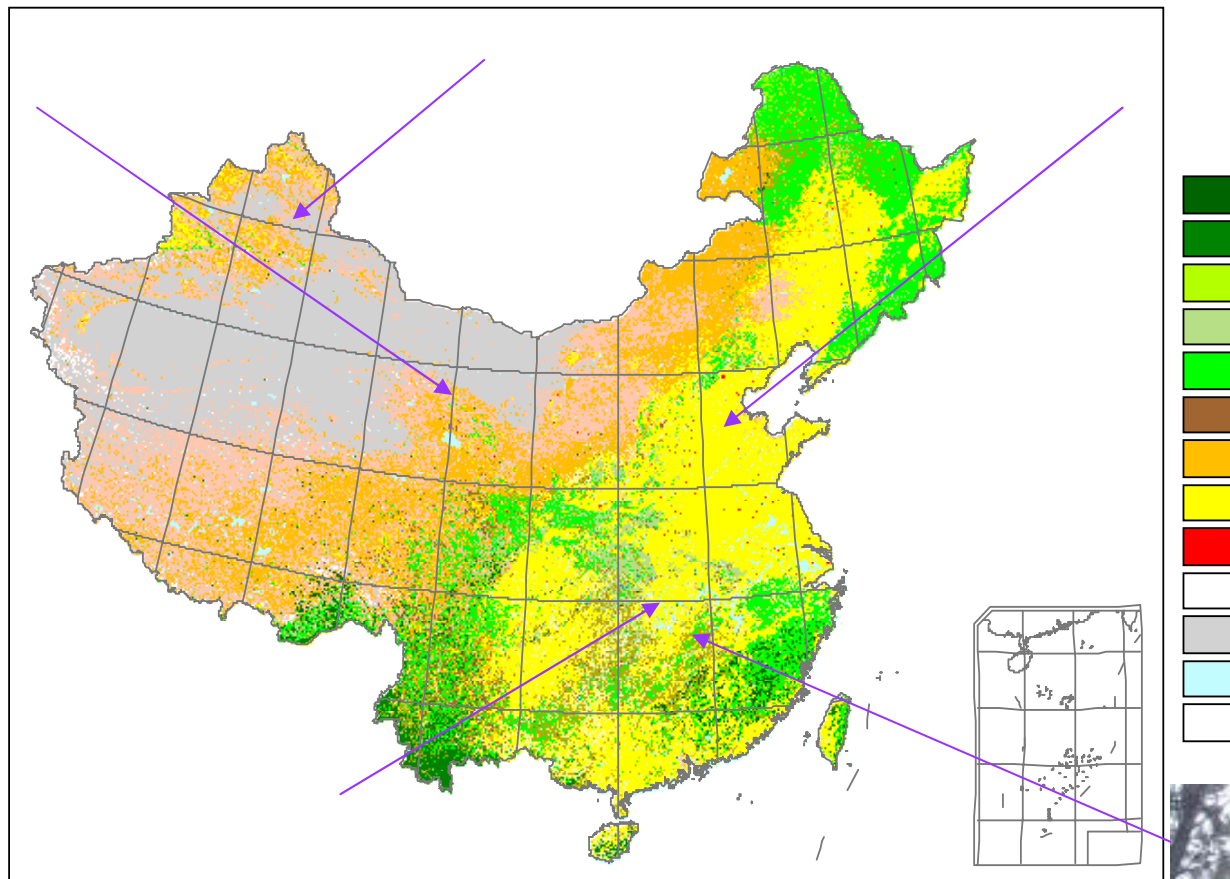
- Philosophy of Sites Selection
 - major ecosystems
 - homogenous
- On line Experiments and Measurements
 - solar radiation, net radiation, PAR:
 - soil heat flux:
 - water vapor and CO₂ fluctuation:
 - photosynthesis:
 - vegetation parameters:

Haibei

Fukang

Yucheng

Taoyuan

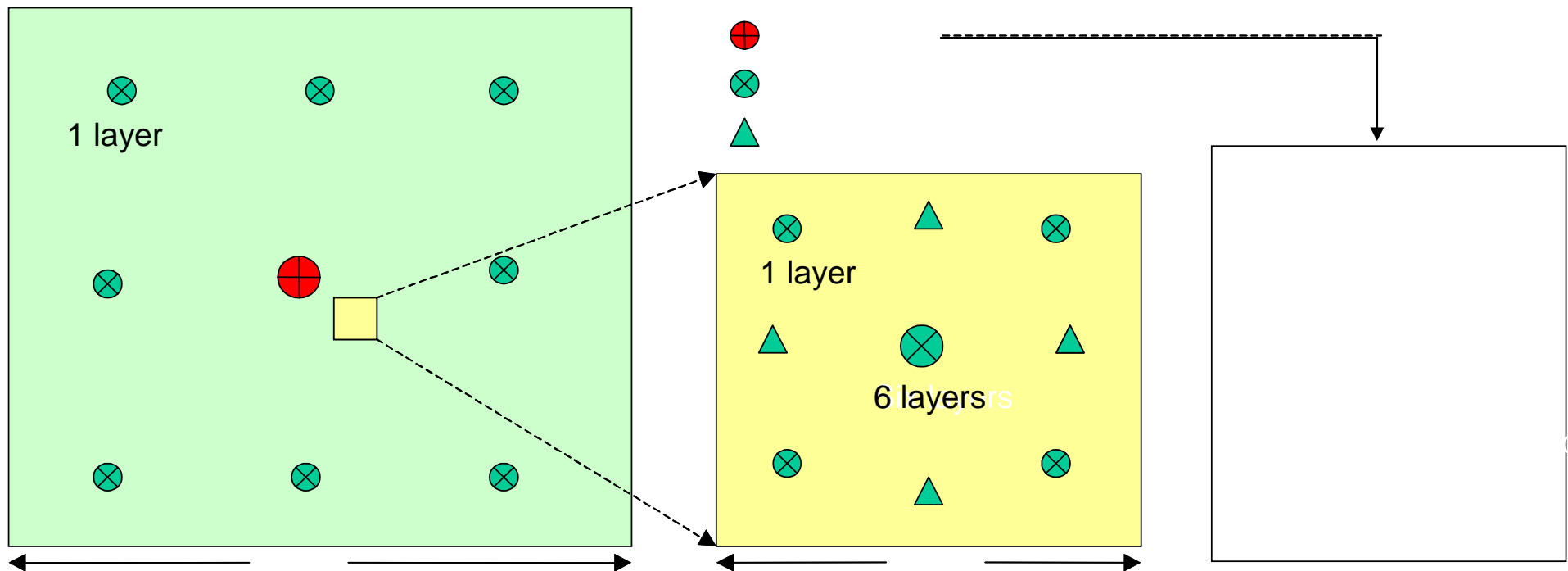
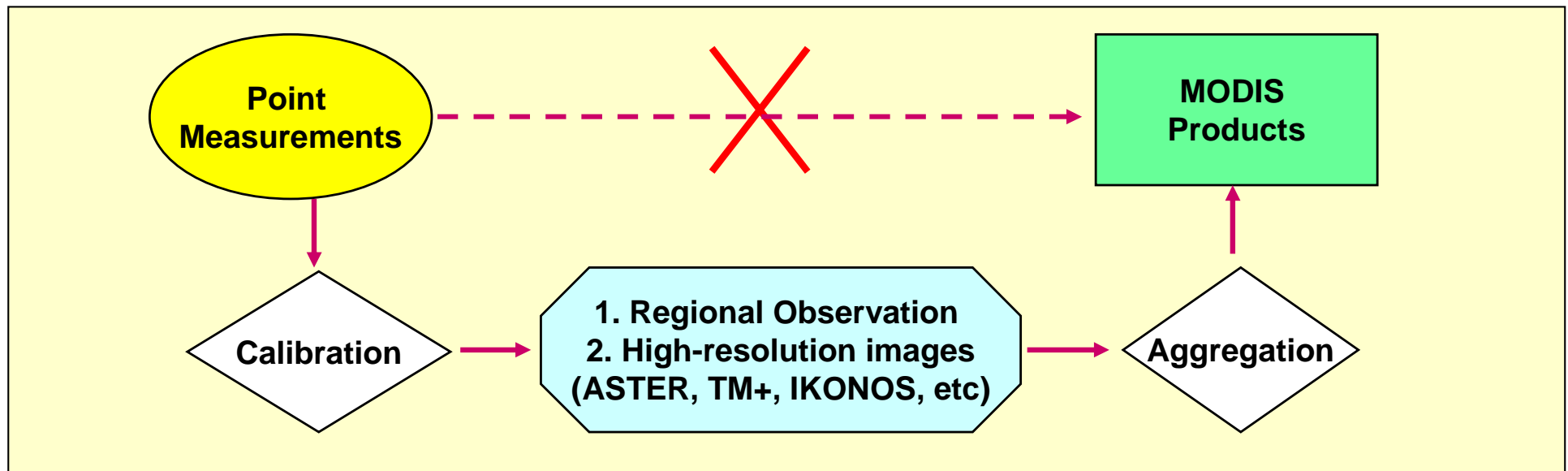


MODIS Land-cover Map of China in 2002

APIES-FLUX towers



Up-scaling Scheme and Observation Design



Long-term Regional Observation (Haibei Site, 2002)

No.6
↓

No.8
↓

No.1
↓

No.7
↓

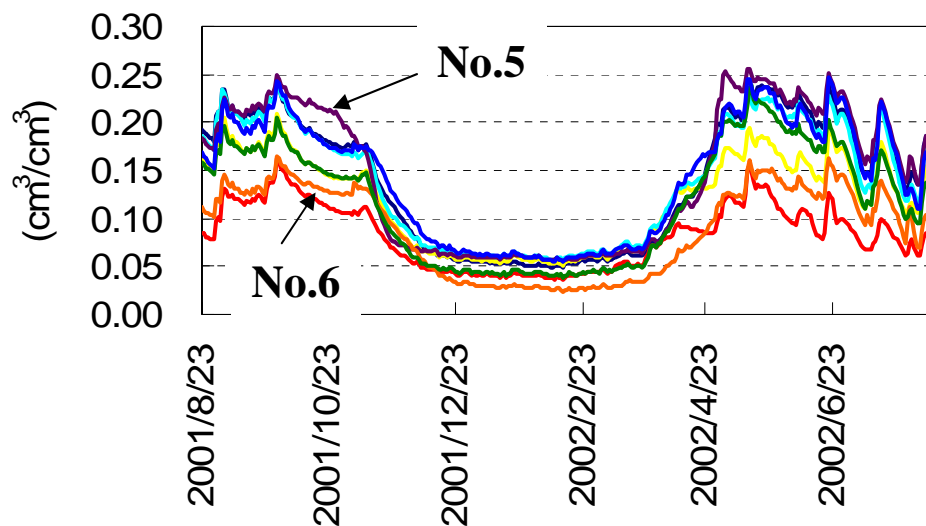
No.5
↓

No.4
↓

通量观测塔
↓

No.0
↓

Soil Water Content



No.2
↓

No.3
↓

Long-term
Monitoring of
Water , Heat
and CO₂ Fluxes
(Yucheng
Site, 2002)

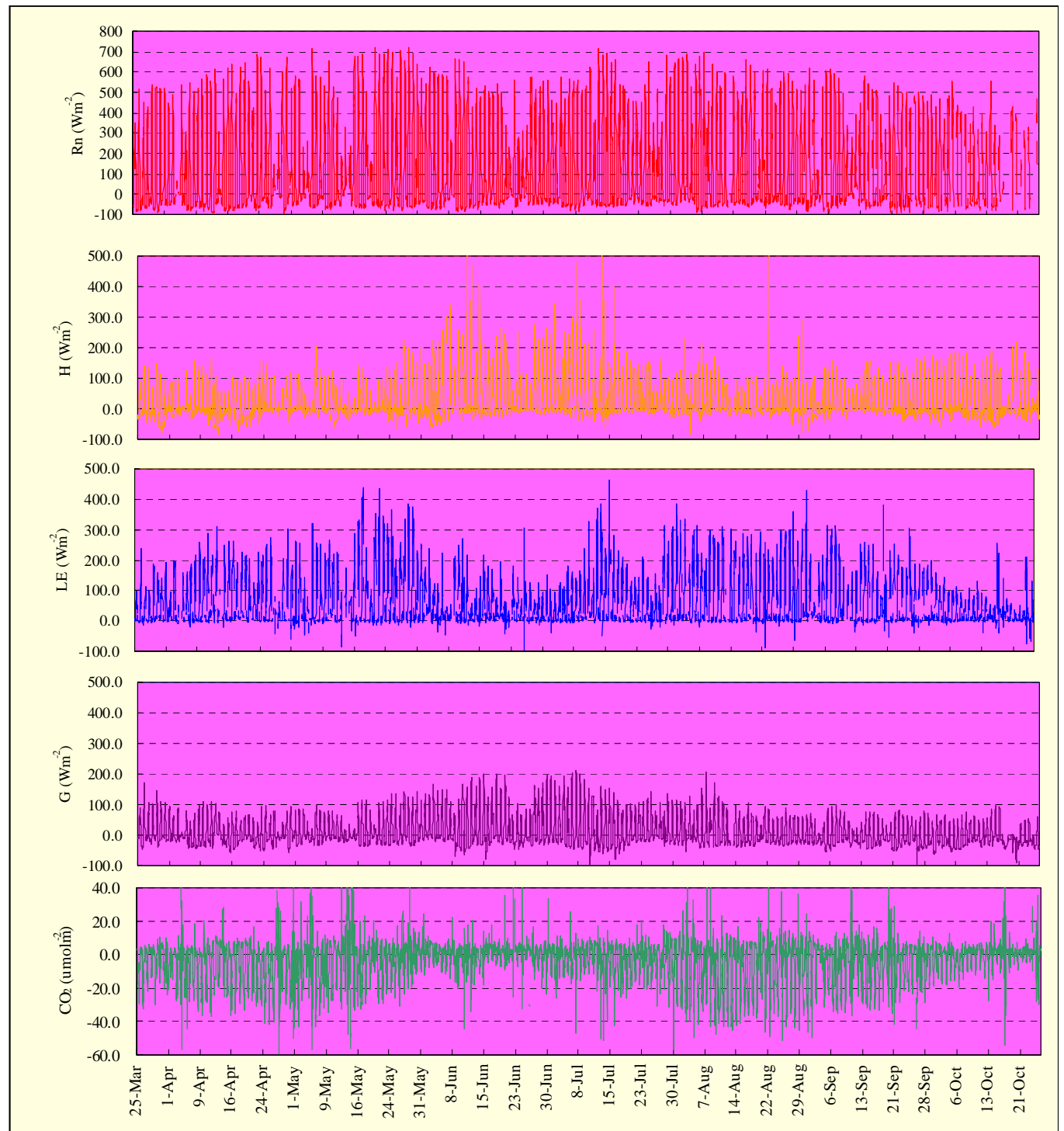
Net Radiation flux

Sensible heat flux

Latent heat flux

Soil heat flux

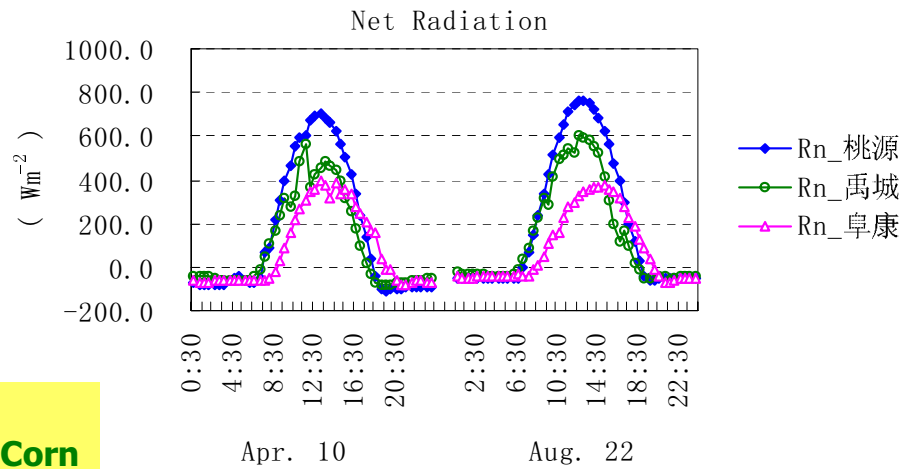
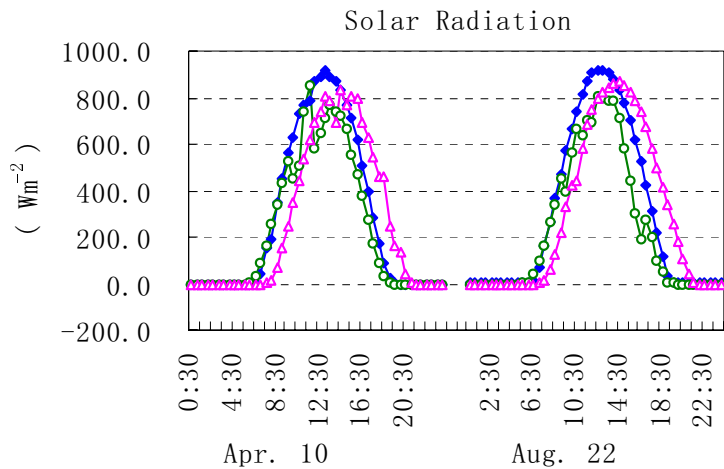
CO₂ flux



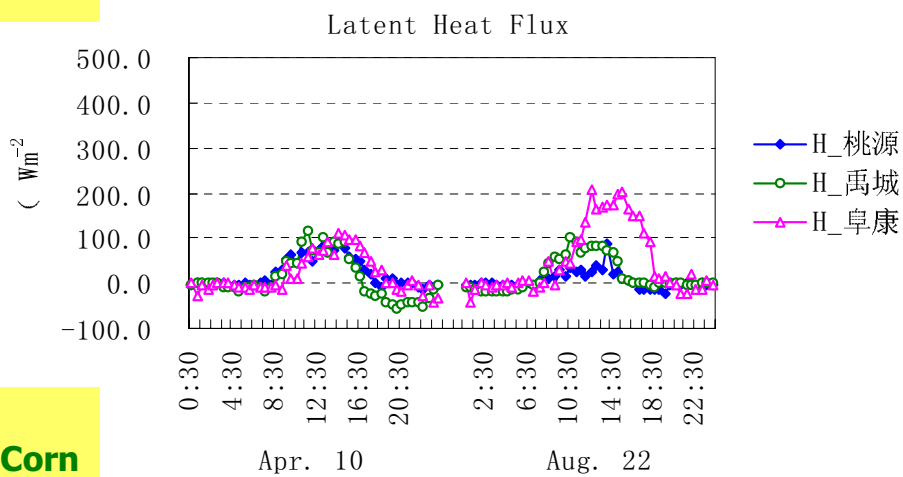
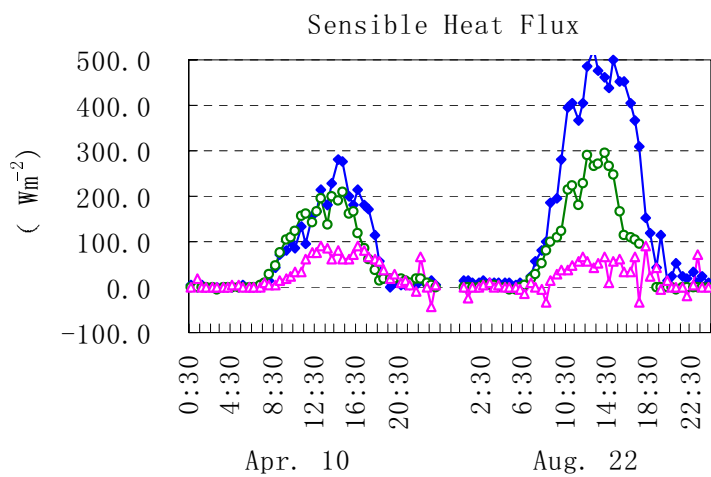
Wheat

Corn

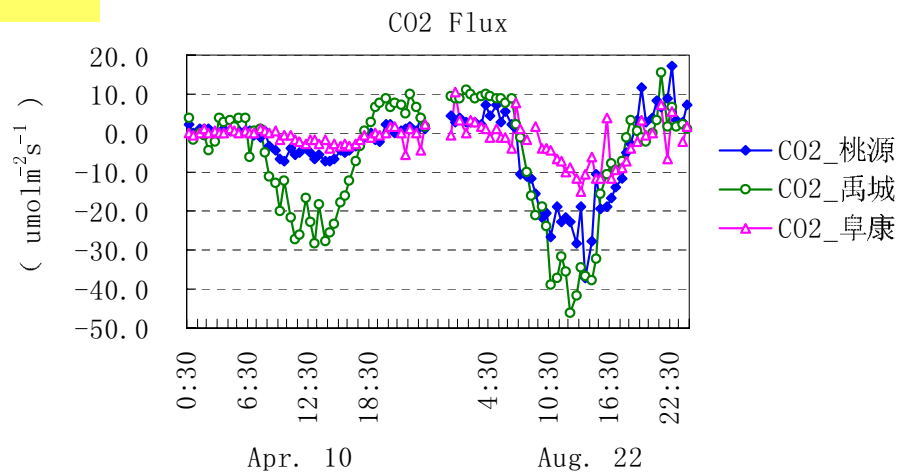
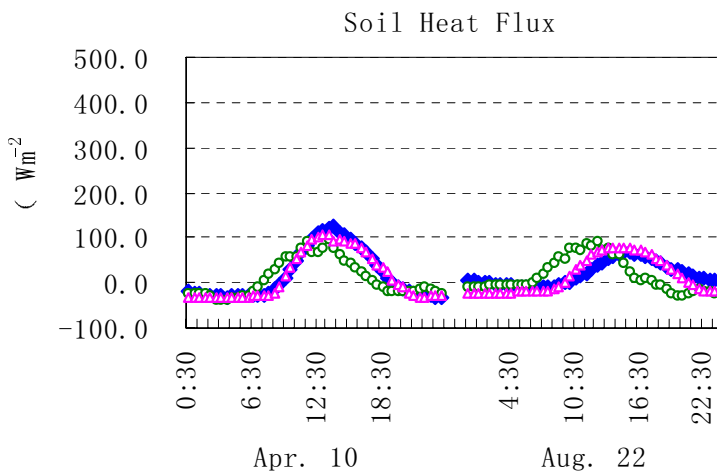
Comparison of fluxes in different biomes



Paddy
Wheat & Corn
Desert



Paddy
Wheat & Corn
Desert





FPAR

Leaf Area Index & FPAR
Photosynthesis and NPP

Integrated Ecosystem models

LAI

MOD11: Weekly Land Surface Temperature (LST), 2003-01-01

MOD11: Weekly Land Surface Temperature (LST), 2003-01-09

MOD11: Weekly Land Surface Temperature (LST), 2003-01-17

MOD11: Weekly Land Surface Temperature (LST), 2003-01-25

MOD11: Weekly Land Surface Temperature (LST), 2003-02-02

MOD11: Weekly Land Surface Temperature (LST), 2003-02-10

MOD11: Weekly Land Surface Temperature (LST), 2003-02-18

MOD11: Weekly Land Surface Temperature (LST), 2003-02-26

MOD11: Weekly Land Surface Temperature (LST), 2003-03-05

MOD11: Weekly Land Surface Temperature (LST), 2003-03-13

MOD11: Weekly Land Surface Temperature (LST), 2003-03-21

MOD11: Weekly Land Surface Temperature (LST), 2003-03-29

MOD11: Weekly Land Surface Temperature (LST), 2003-04-06

MOD11: Weekly Land Surface Temperature (LST), 2003-04-14

MOD11: Weekly Land Surface Temperature (LST), 2003-04-22

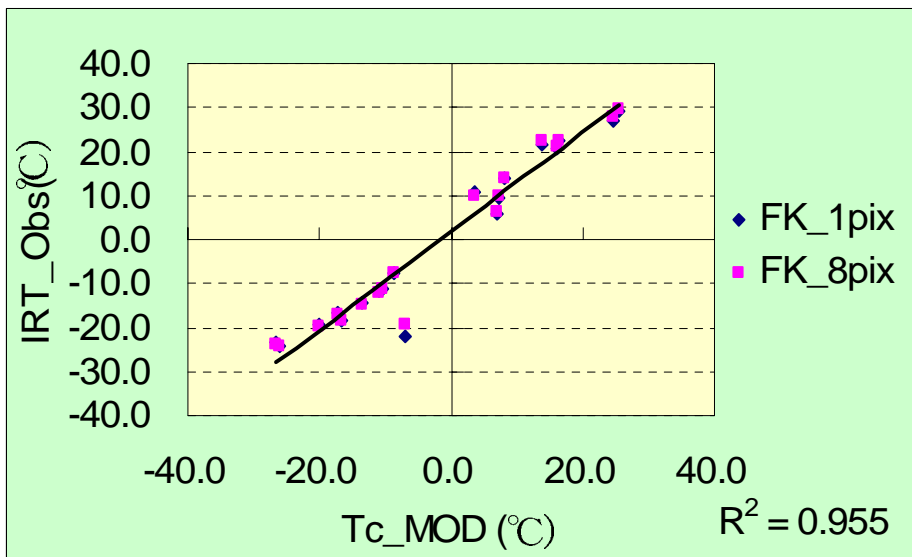
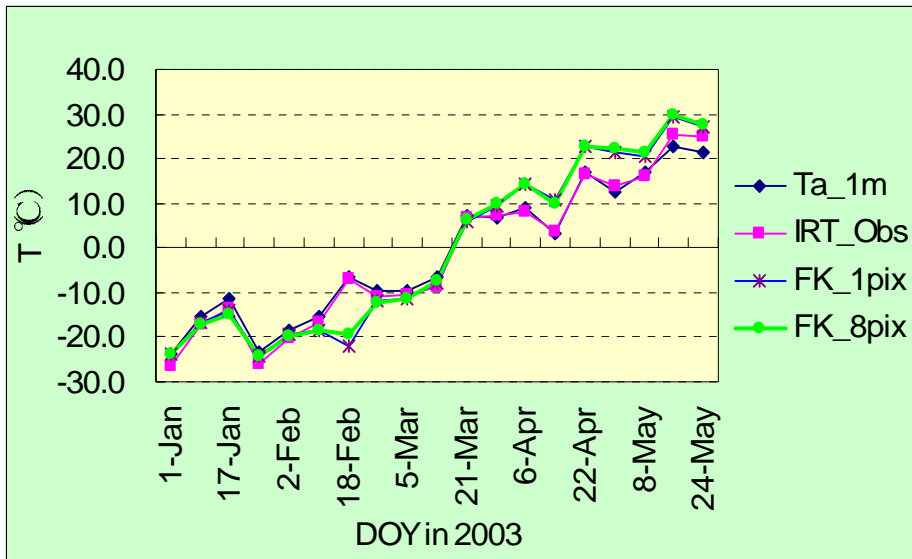
MOD11: Weekly Land Surface Temperature (LST), 2003-04-30

MOD11: Weekly Land Surface Temperature (LST), 2003-05-08

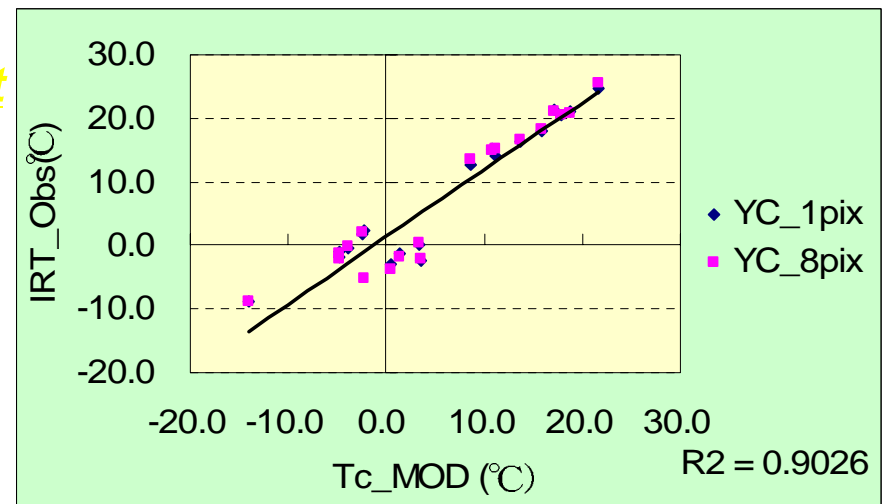
MOD11: Weekly Land Surface Temperature (LST), 2003-05-16

MOD11: Weekly Land Surface Temperature (LST), 2003-05-24

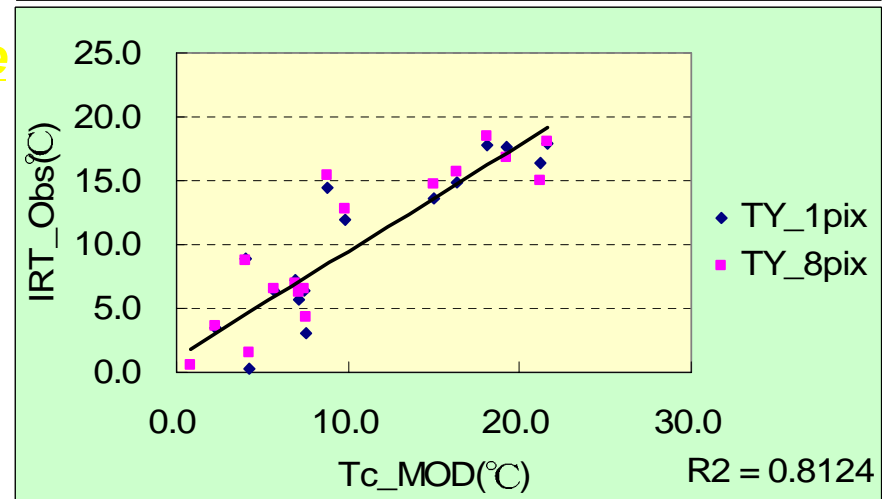
Validation of MOD11: Land Surface Temperature of major biomes in 2003



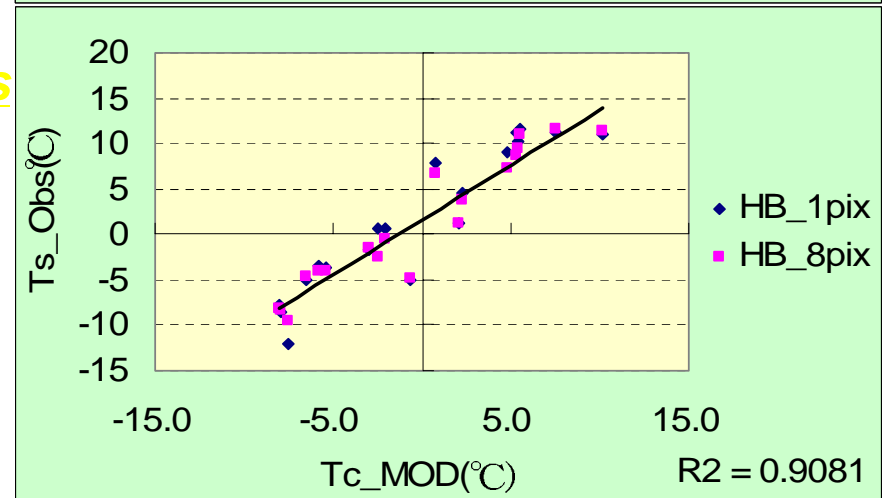
Wheat



Rice

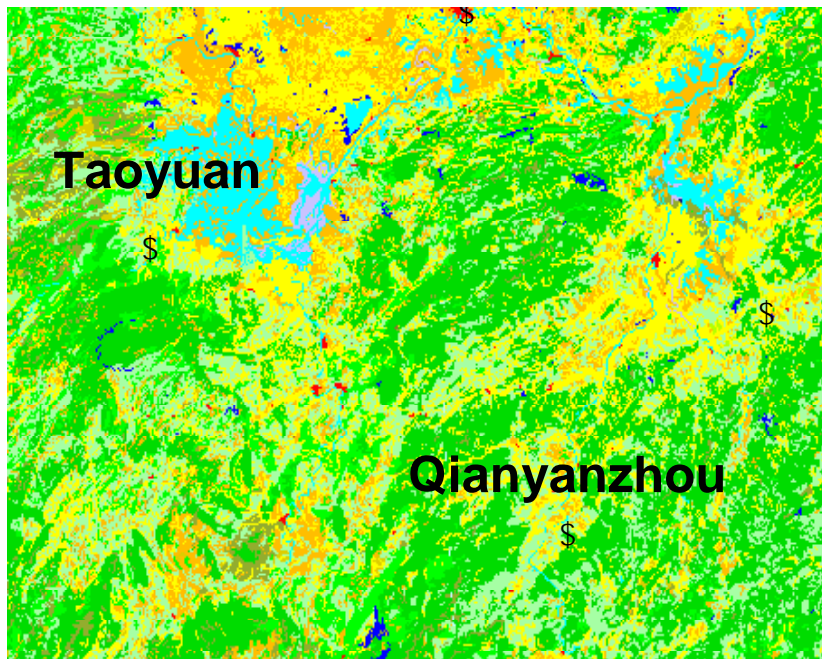


Grass



Desert

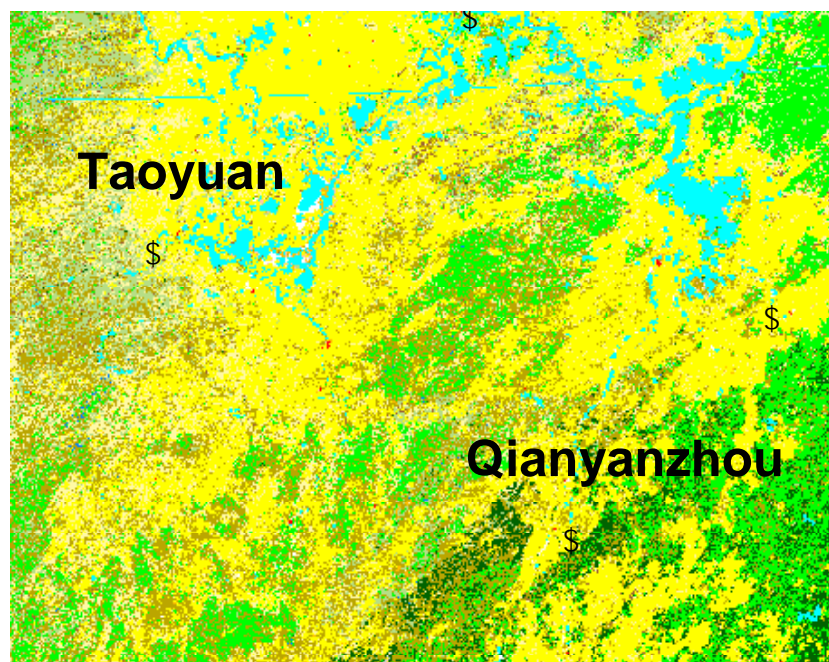
Land Cover
Map of China
(Liu J., 2000)



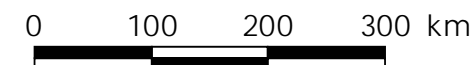
- Chi na LU
- Forest
 - Bush
 - Spar se Wood
 - Q her Wood Land
 - Hi gh Grass - ranti ed Land
 - Moder at el y Grass - ranti ed Land
 - Low Grass - ranti ed Land
 - Ri ver and Lakes
 - Reser vi or
 - Bot t om and
 - Q ty and Town
 - V ill age
 - Q her Const ruct i on Land
 - Swamp
 - Bar e Land
 - Bar e - r ock and Shi ngl e
 - Q her Wast e Land
 - Paddy
 - Dry Far m Land
 - Paddy
 - Dry Far m Land
 - No Dat a



MODIS
Land Cover
(2000)

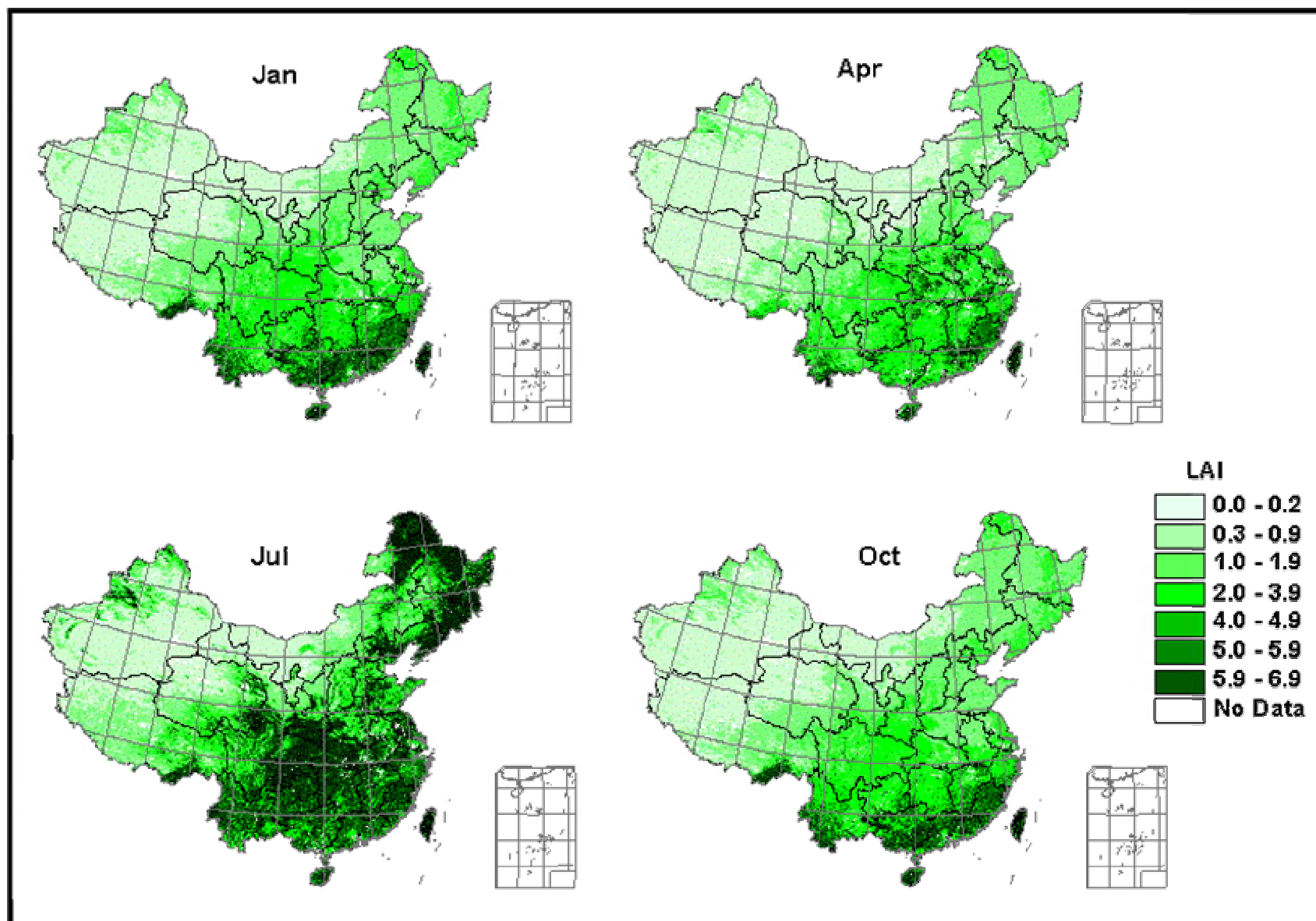


- MODIS
- Ever gr een Needl eaf For est
 - Ever gr een Br oadl eaf For est
 - Deci duous Needl eaf For est
 - Deci duous Br oadl eaf For est
 - Mixed For est
 - C los ed Shr ubl and
 - Op en Shr ubl and
 - Woody Savannas
 - Savannas
 - Gr assl and
 - Per manent Wetl and
 - Op l and
 - Op l and/ Nat ur al Veget at i on Mbs ai c
 - Ur ban and Bui l t - up
 - Snow and Ice
 - Bar ren or Spar sel y Veget at ed
 - Wat er Body
 - Q her



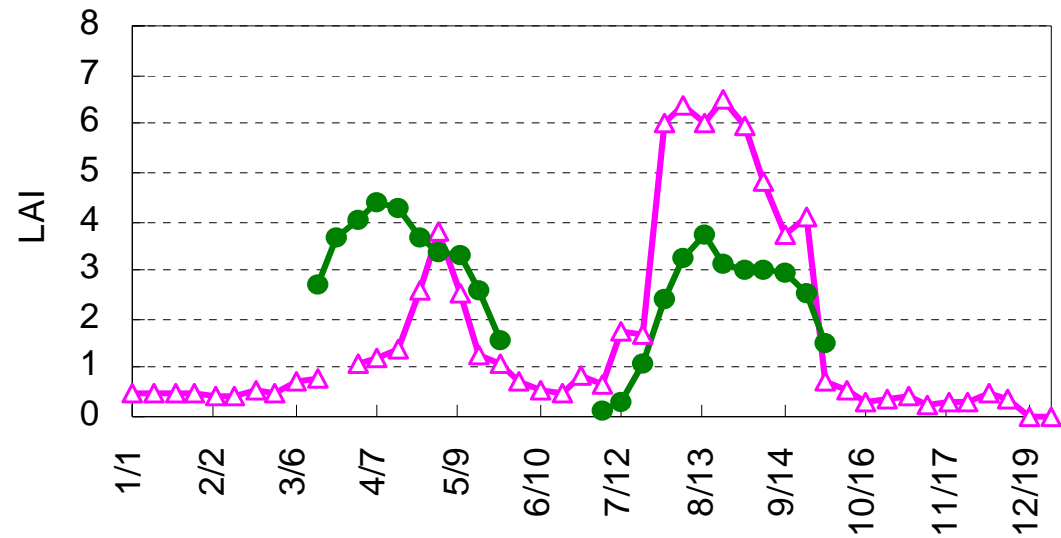
Validation of MOD12: Land Cover Product

MOD15: Seasonal Changes of LAI in 2002

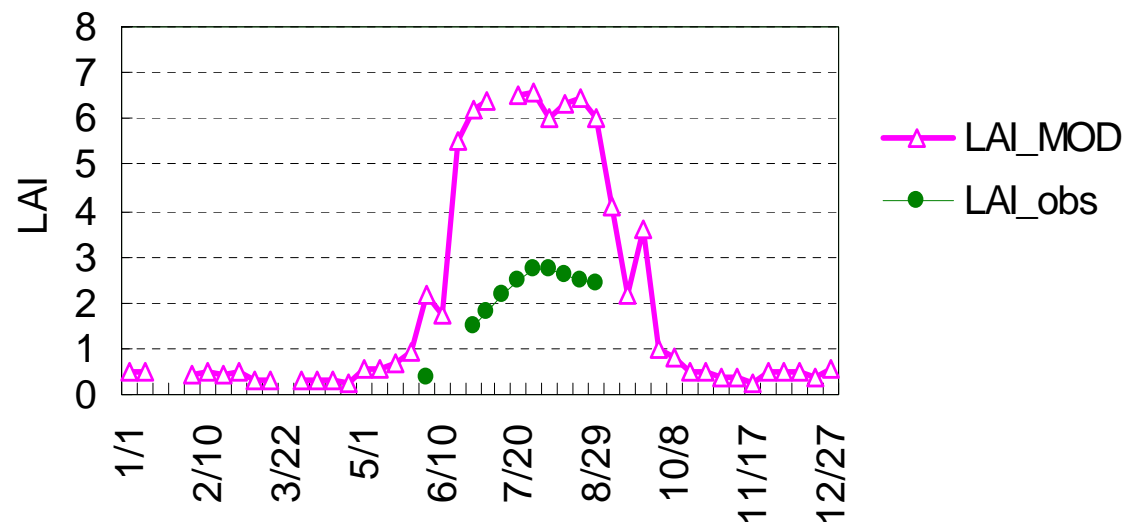


**Validation of MOD15:
Leaf Area Index
of major biomes
in 2002**

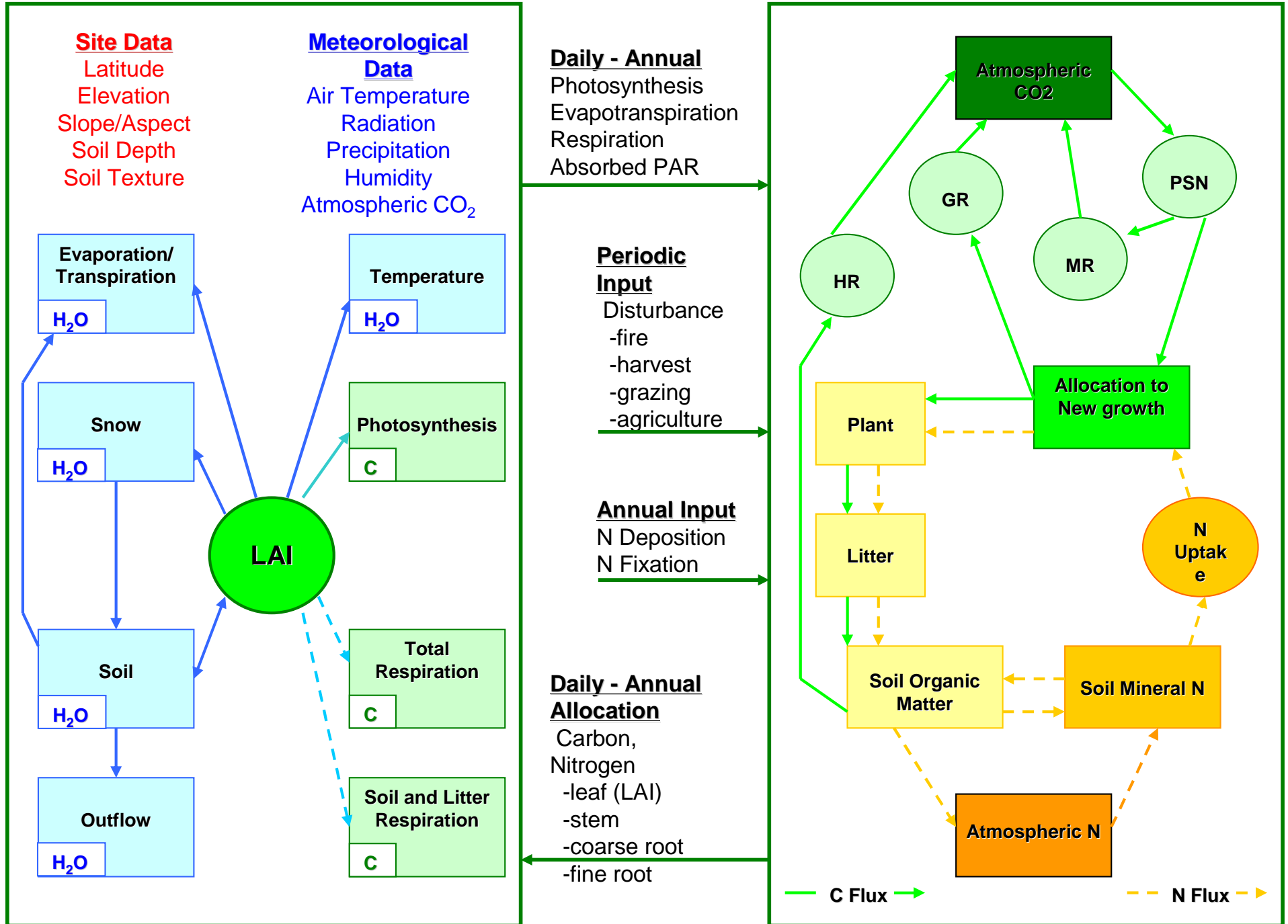
LAI, Yucheng / Wheat & Corn, 2002



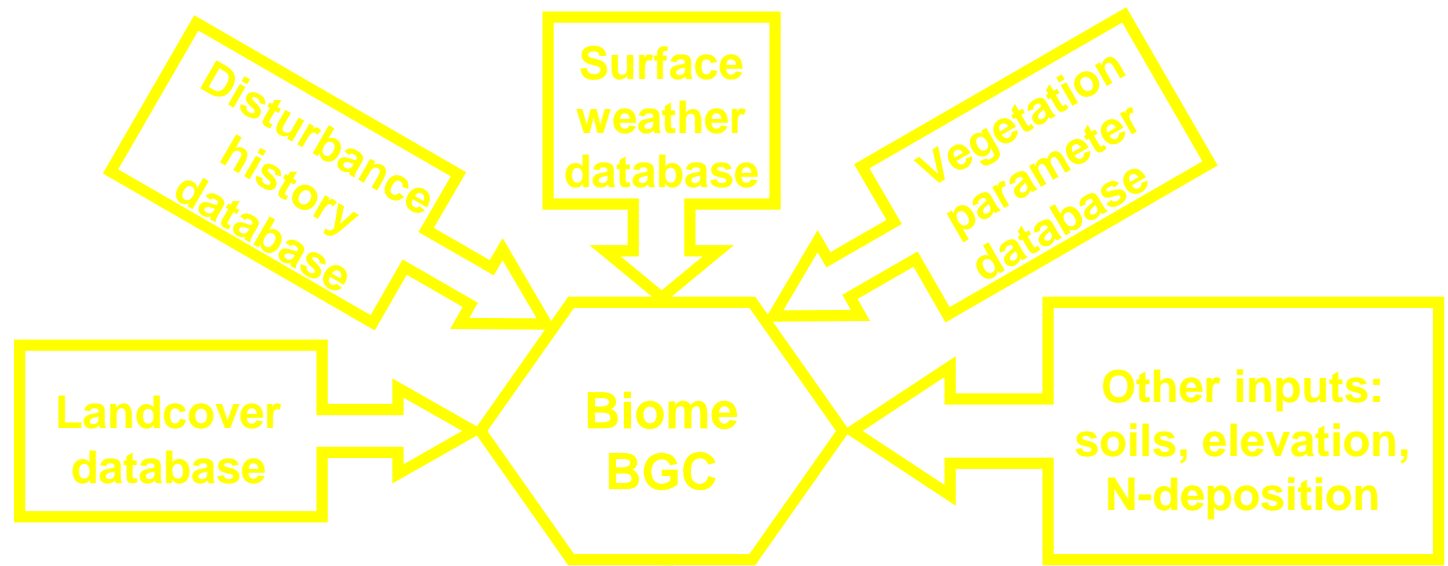
LAI, Haibei / Grass, 2002



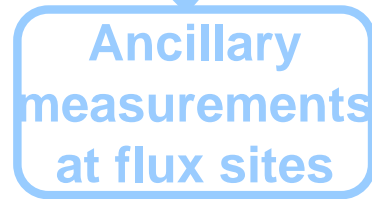
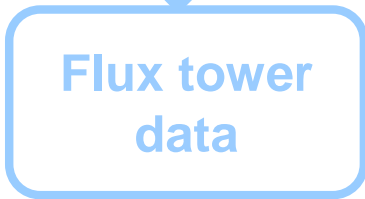
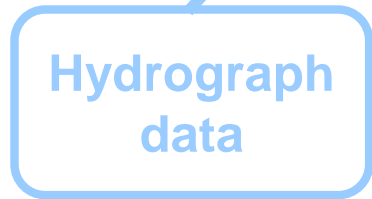
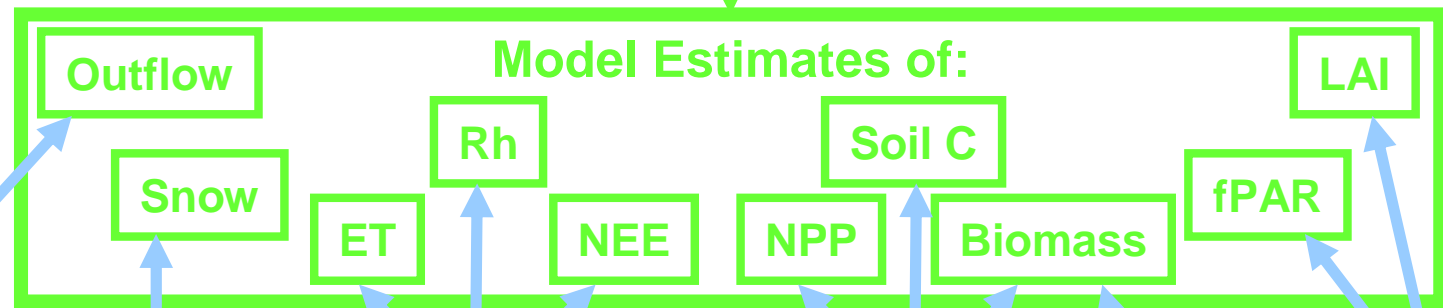
Structure of Biome-BGC Ecosystem Model



Integration



Simulation



Validation

MODIS NPP Algorithm



Here, the Monteith equation was used for GPP

Radiation Use Efficiency

Absorbed Photosynthetically Active Radiation

$GPP = \epsilon \times APAR$

$APAR = (FPAR) (0.45R_{net})$

Radiation Use Efficiency was estimated by:

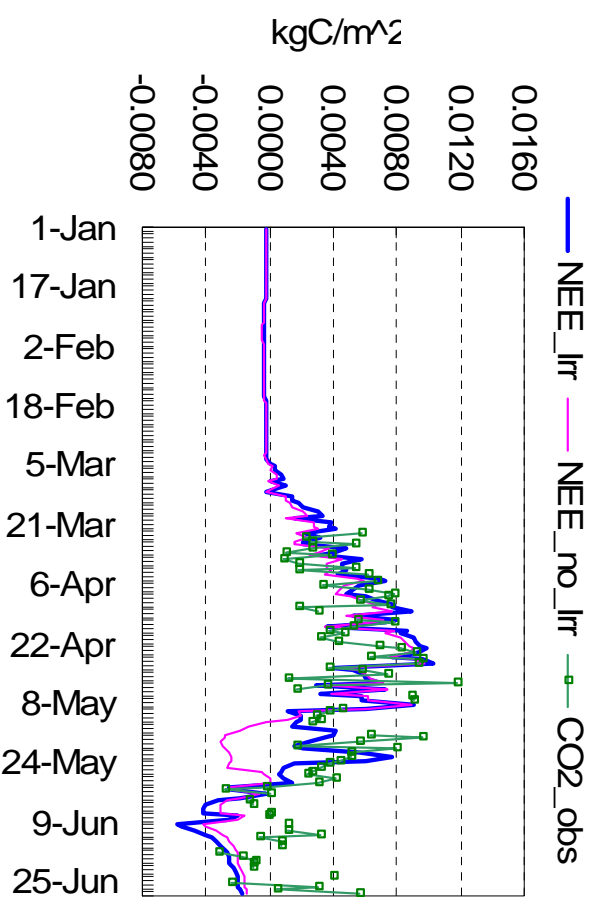
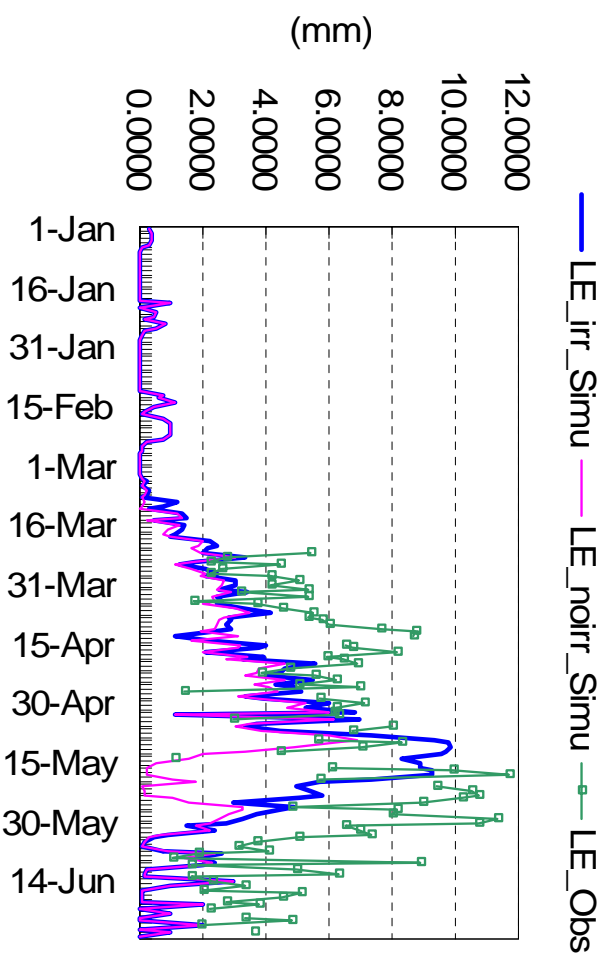
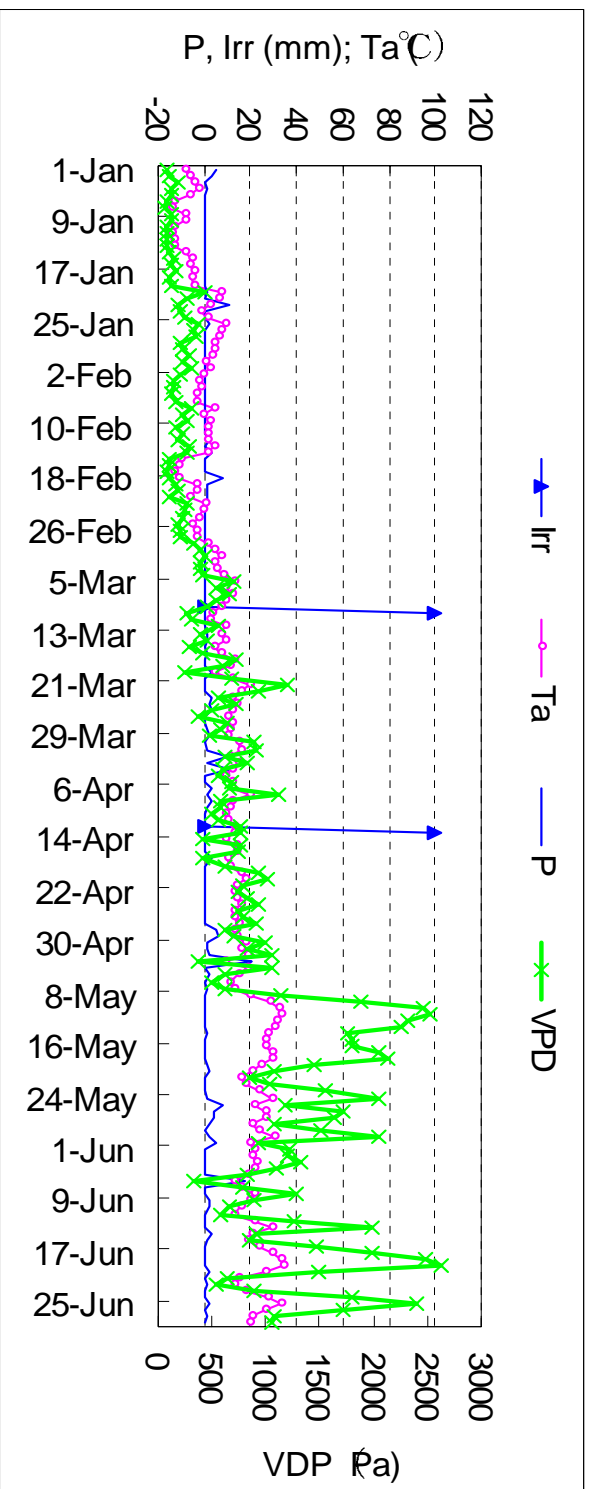
*Maximum
Radiation Use Efficiency
under ideal conditions
for each biome*

*Vapor Pressure Deficit
Coefficient
for each biome*

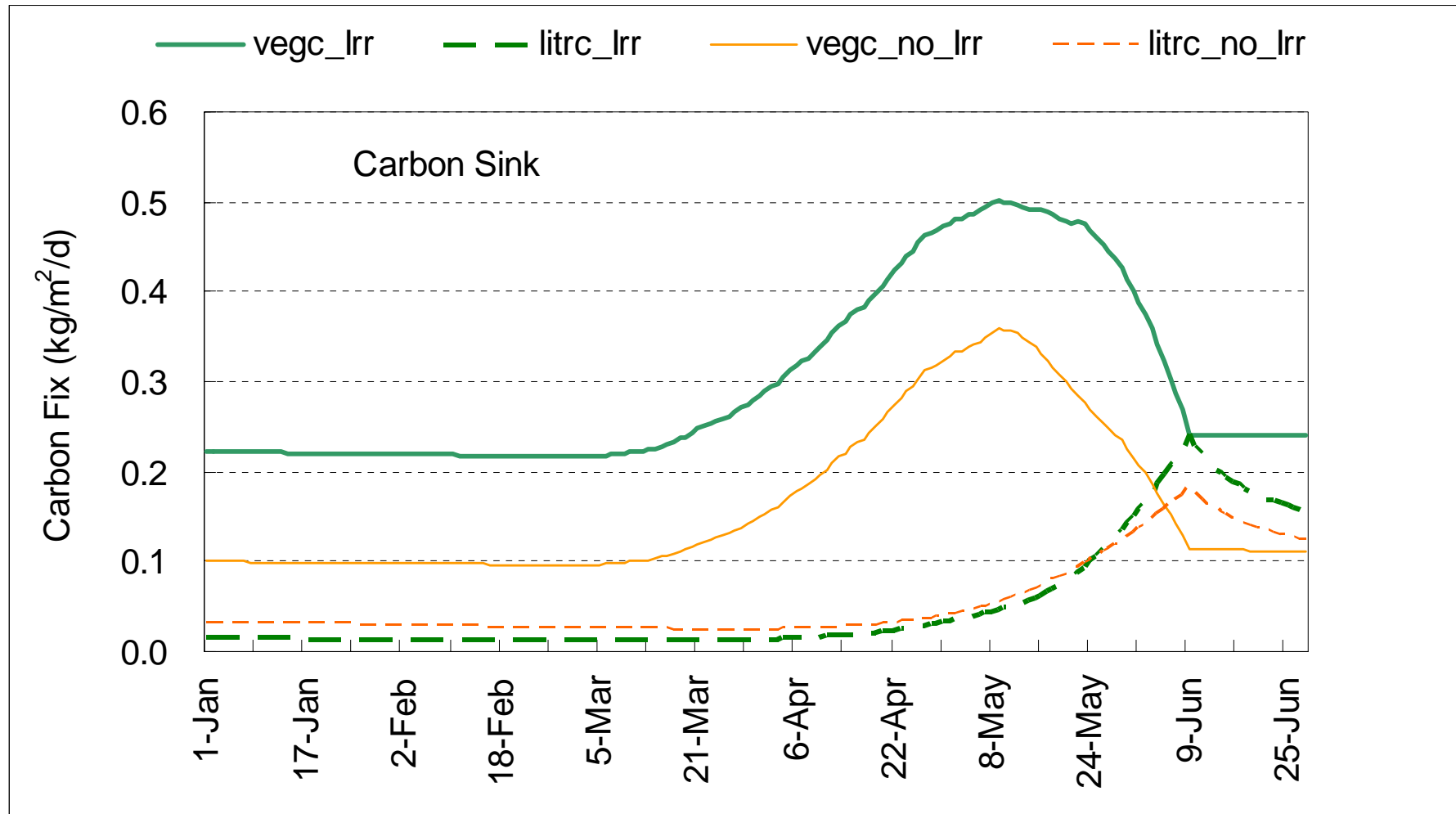
$$\epsilon = \epsilon_{max} [C_{tmin}] [C_{vpd}]$$

Temperature Coefficient for each biome

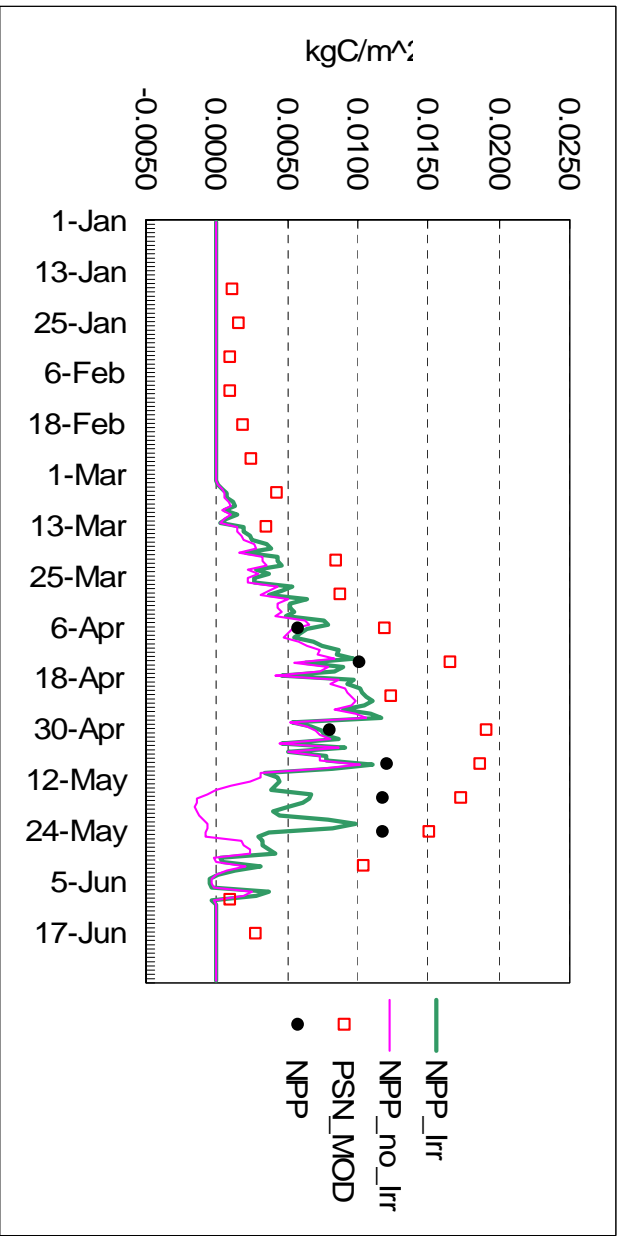
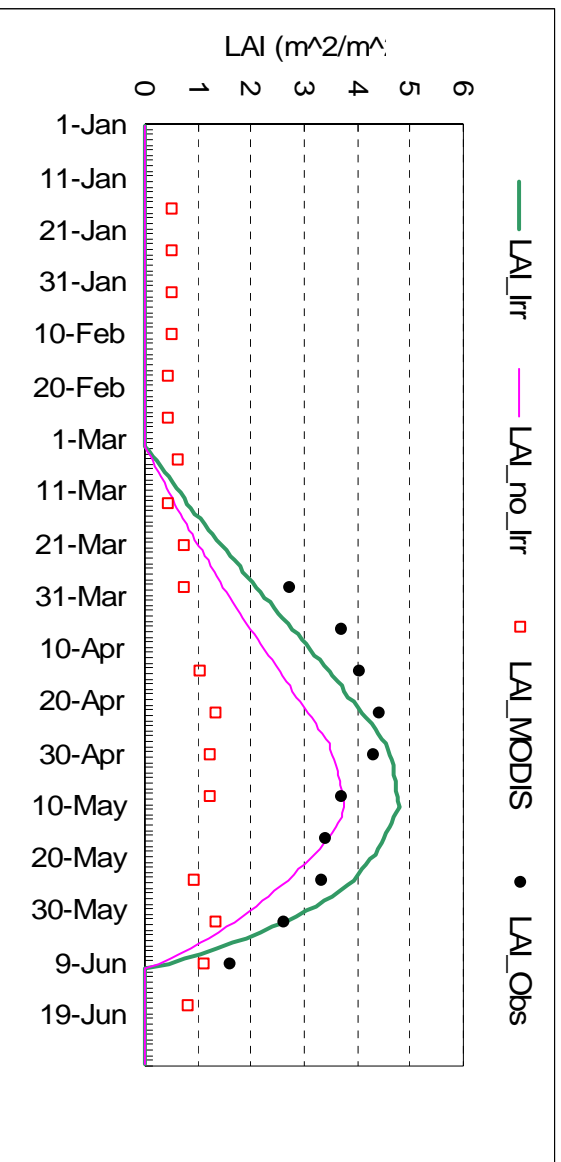
BIOME-BGC Estimates of Water and Carbon Fluxes (Yucheng/wheat Site, 2002)



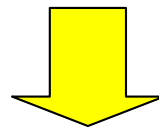
BIOME-BGC Estimates of Cumulative Net Carbon Exchange (Yucheng/wheat Site, 2002)



Biome-BGC Estimates of LAI & NPP, Comparing with Observations and MODIS Products (Yucheng/wheat site, 2002)



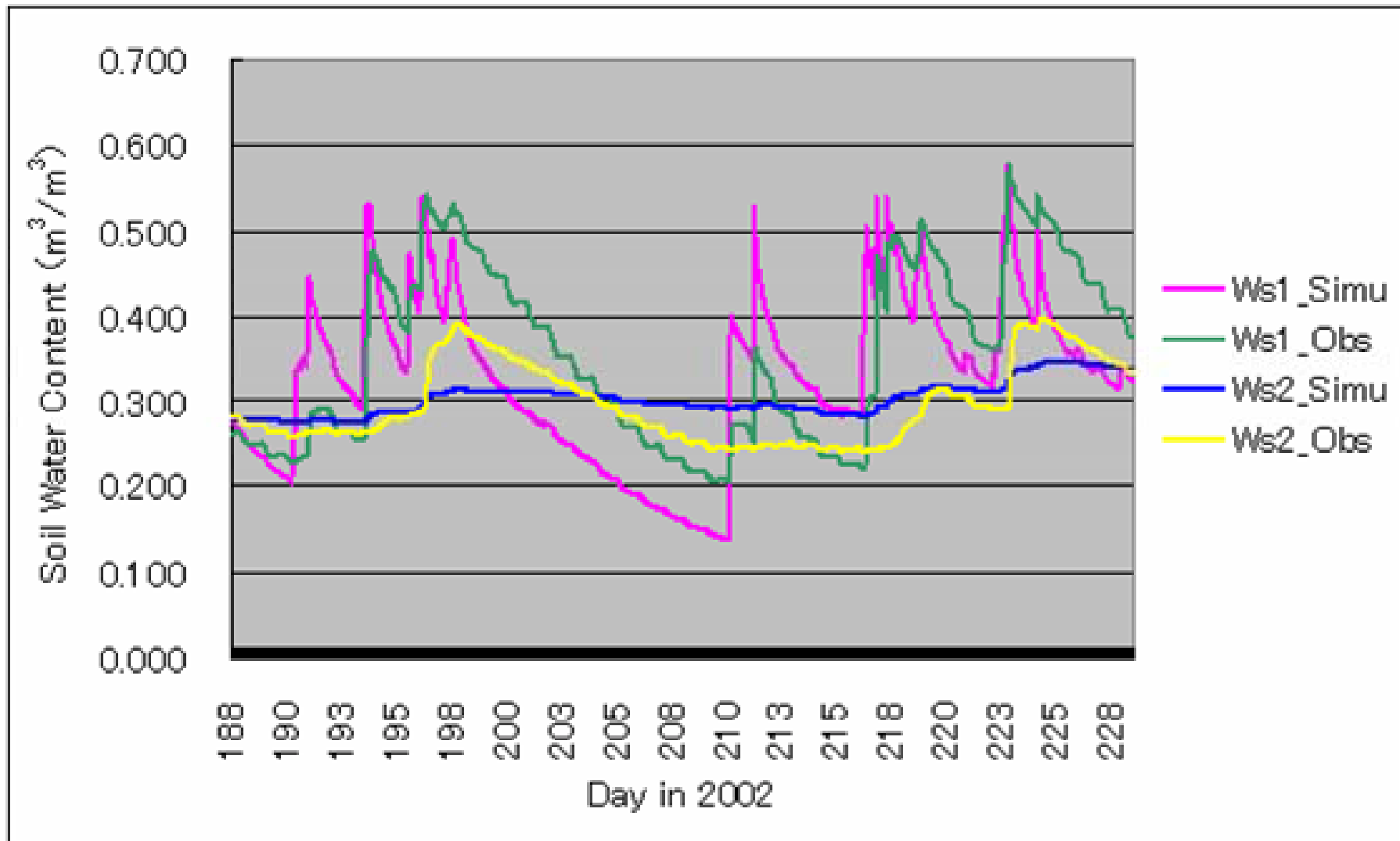
Some Findings



- So, please be careful when you use NASA's Products, at least, for the simulation in Asia-pacific regions
- It is expected that APIES-IEM will soon develop more realizable high-order land products in Asia-pacific region.

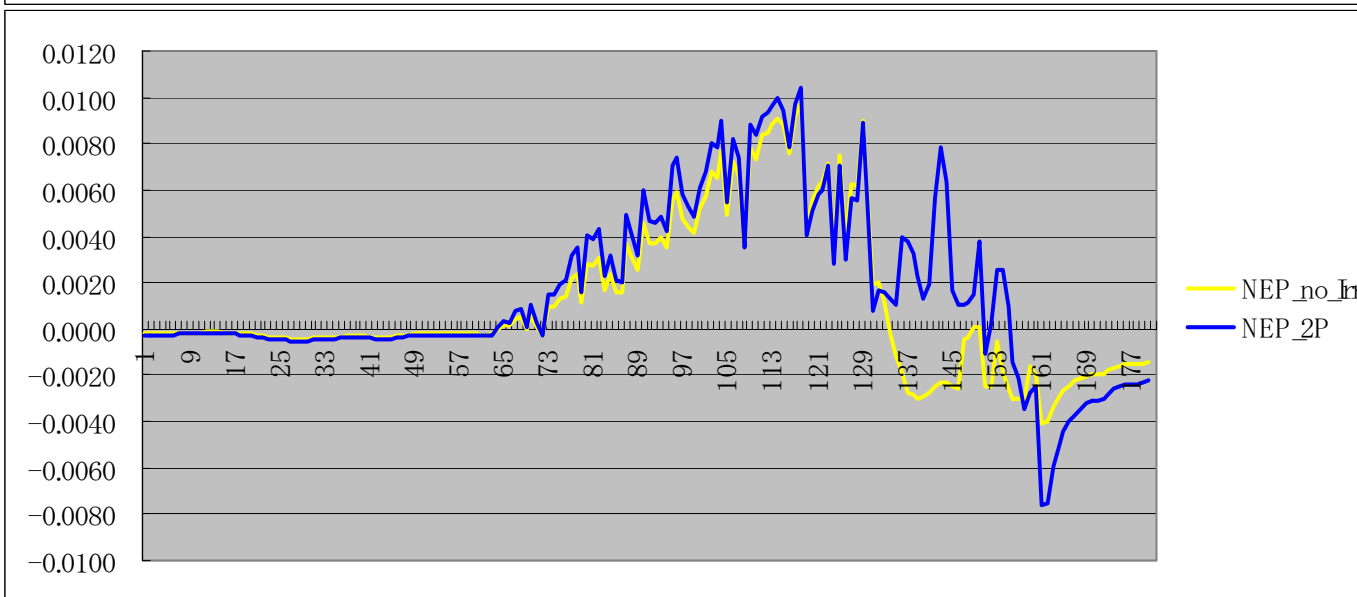
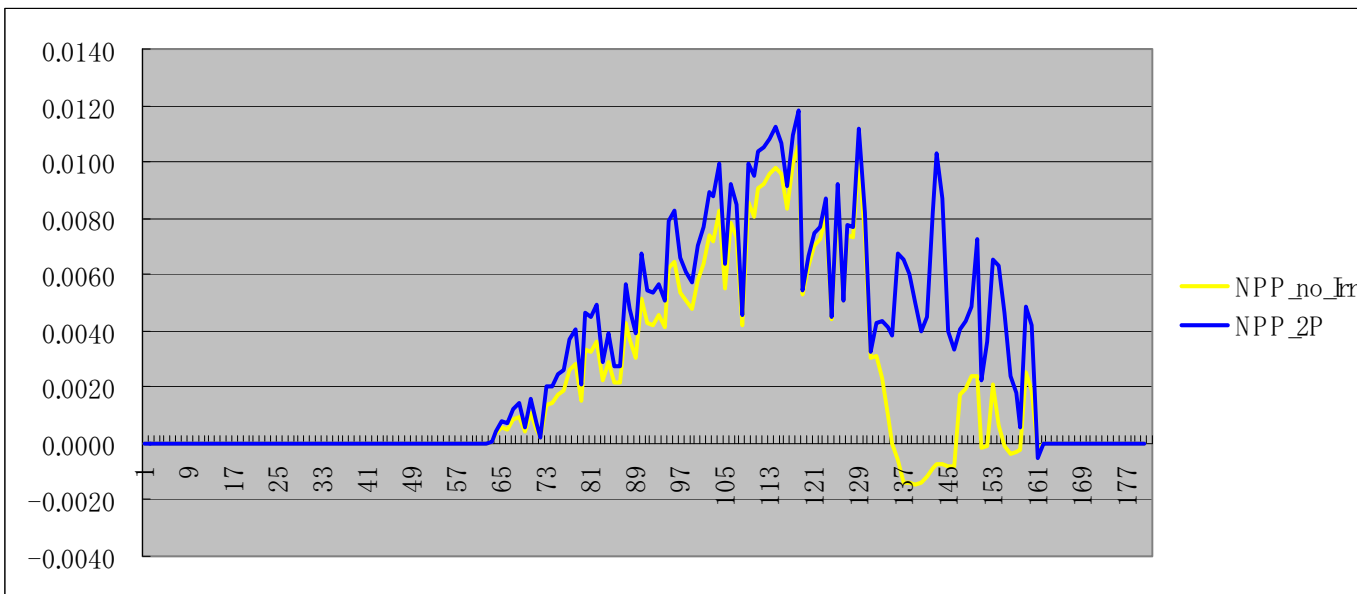
Thank you !

SiB2 Estimates of Soil Water Moisture (Haibei Site, 2002)



Biome-BGC Estimates of NPP, NEP under climate changes

--- In the case of precipitation in 2002 doubled, at Yucheng/wheat site ---



DSSAT Estimates of Maize Growth and Corn Yield (Yucheng site, 2002)

GRAIN YIELD (kg/ha; dry) 7821 8002

MAXIMUM LAI (m²/m²) 3.83 3.94
BIOMASS (kg/ha) 15954 15582

HARVEST INDEX (kg/kg) 0.490 0.52

