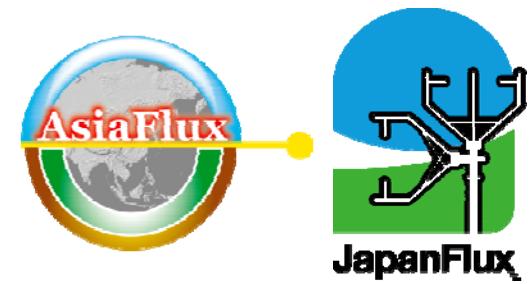


# *Integrative use of AsiaFlux Network Observations for Continental-scale Estimates of Carbon Budget*

Nobuko Saigusa

National Institute for Environmental Studies  
(**AsiaFlux** Tsukuba Office)  
Tsukuba, Japan





# Contents

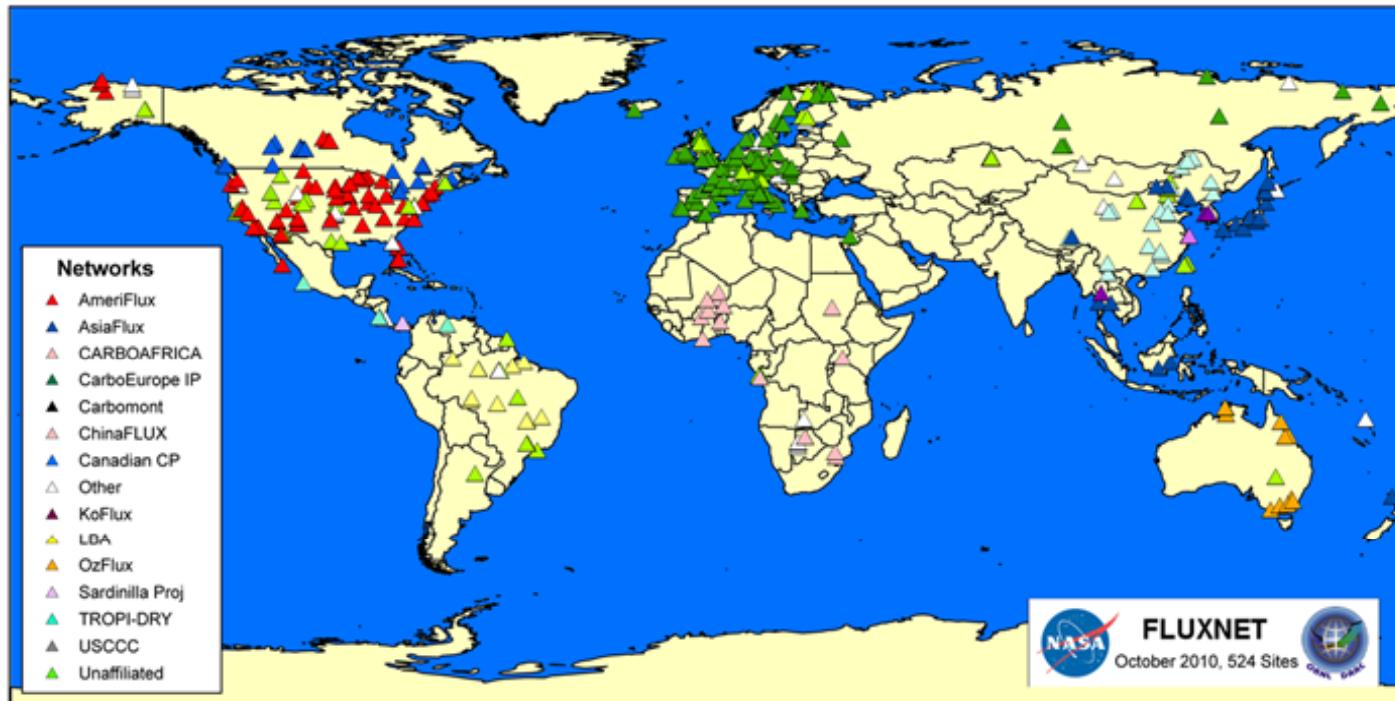
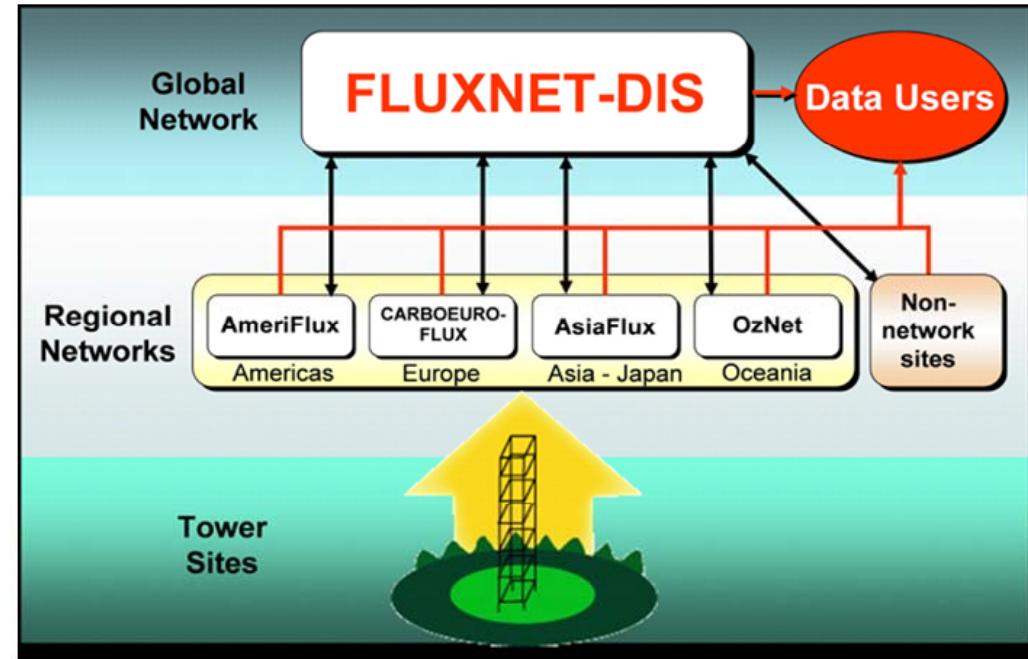
1. Integrative Use of FLUXNET-AsiaFlux Network Observations
  - What are FLUXNET and AsiaFlux?
2. Continental-scale Estimates of Carbon Budget
3. Needs and the Next Step



# FLUXNET:

World-wide network for monitoring CO<sub>2</sub>, H<sub>2</sub>O, and energy exchanges between terrestrial ecosystems and the atmosphere

(> 500 sites)



Distribution of FLUXNET sites

<http://www.fluxnet.ornl.gov>



# AsiaFlux: a regional network in FLUXNET (1999~)

<http://www.asiaflux.net/>



## Organization

- Chair: Kim J (Korea)
- Vice-chairs: Miyata A (Japan)  
Li SG (China)

## Sites in Asia

- **No. of registered sites: 83**
- National (regional) networks:  
ChinaFlux, JapanFlux, KoFlux,  
TaiwanFlux, ThaiFlux, (India),...

## Activities

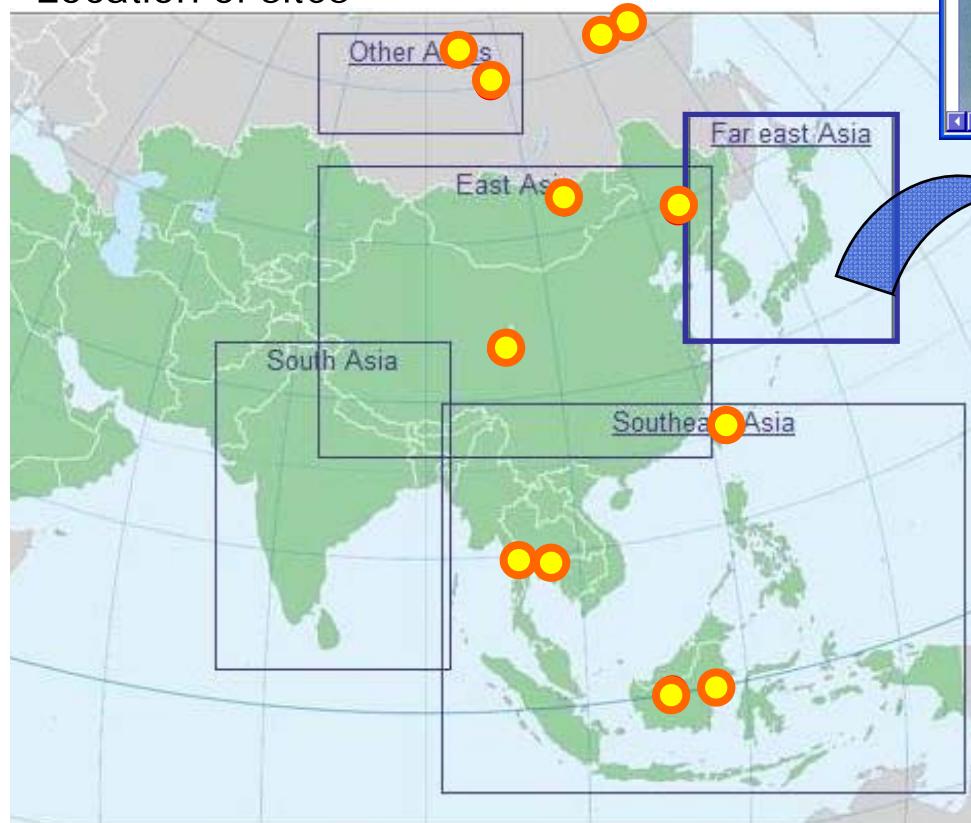
- Workshop, Training course
- Educational materials
- Web site, Mailing list
- Database
- Newsletter (2 issues/year)

# AsiaFlux Database

[http://www.asiaflux.net  
/datapolicy.html](http://www.asiaflux.net/datapolicy.html)

- Started in 2007
- 23 sites, 89 site-year data

Location of sites



The screenshot shows the 'Data Source' page of the AsiaFlux website. At the top, there's a banner featuring a close-up of a pine branch. The header bar includes the 'AsiaFlux Website -- Data Source -- Microsoft Internet Explorer' title, file menu (ファイル), edit menu (編集), view menu (表示), Japanese input (おきに入り), tools menu (ツール), help menu (ヘルプ), address bar (アドレス) with the URL <http://www.asiaflux.net/datapolicy.html>, and a search bar (ここから JWord 検索). Below the header is a navigation menu with links to Home, About Us, Activities, Site Info, Data, Newsletter, Resources, Member's Area, and Sitemap. The main content area has a dark blue background and is titled 'Data Source'. It contains four buttons: 'Data Policy' (highlighted in a white box), 'Data Access', 'Call for Data', and 'Data Submission'. To the right of these buttons is a section titled 'AsiaFlux Database' with descriptive text and a bulleted list of benefits.

**AsiaFlux Database**

AsiaFlux now stands in the entrance to a next research phase of integrative and/or inter-comparative studies. AsiaFlux activities are performed under diverse countries, languages and cultures. AsiaFlux will try to combine data from such activities. Coordinated database system is sure to facilitate the multidirectional studies in flux researching communities. Development of an easy-to-use open database system, "AsiaFlux Database (AsiaFluxDB)", is one of the key activities of AsiaFlux. An effective use of the AsiaFluxDB provides a number of benefits, including:

- Distinguishing (extract) essential characteristics of material exchanges between individual sites (ecosystems) and the atmosphere,
- Advances in understanding of material circulation in Asian region,
- Contribution to Asian environmental management strategy by extending cooperation with the modeling and remote sensing communities, and
- Efficient upgrading of observation techniques and analysis processes.

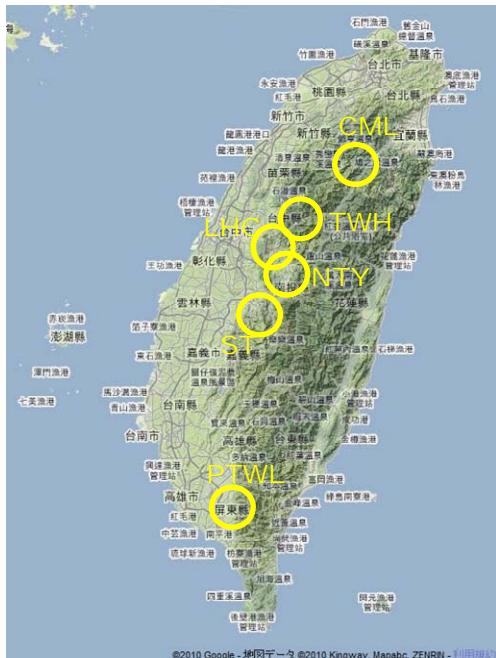


# Member network TaiwanFlux

<http://140.112.63.212/tflux.html>

Kick-off workshop  
at Sitou (溪頭) Site  
National Taiwan Univ.  
December 6-7, 2010

Sites in Taiwan



AsiaFlux Workshop 2007

Kick-off workshop of  
Taiwan Flux  
October 19-21, 2007  
Taoyuan, Taiwan



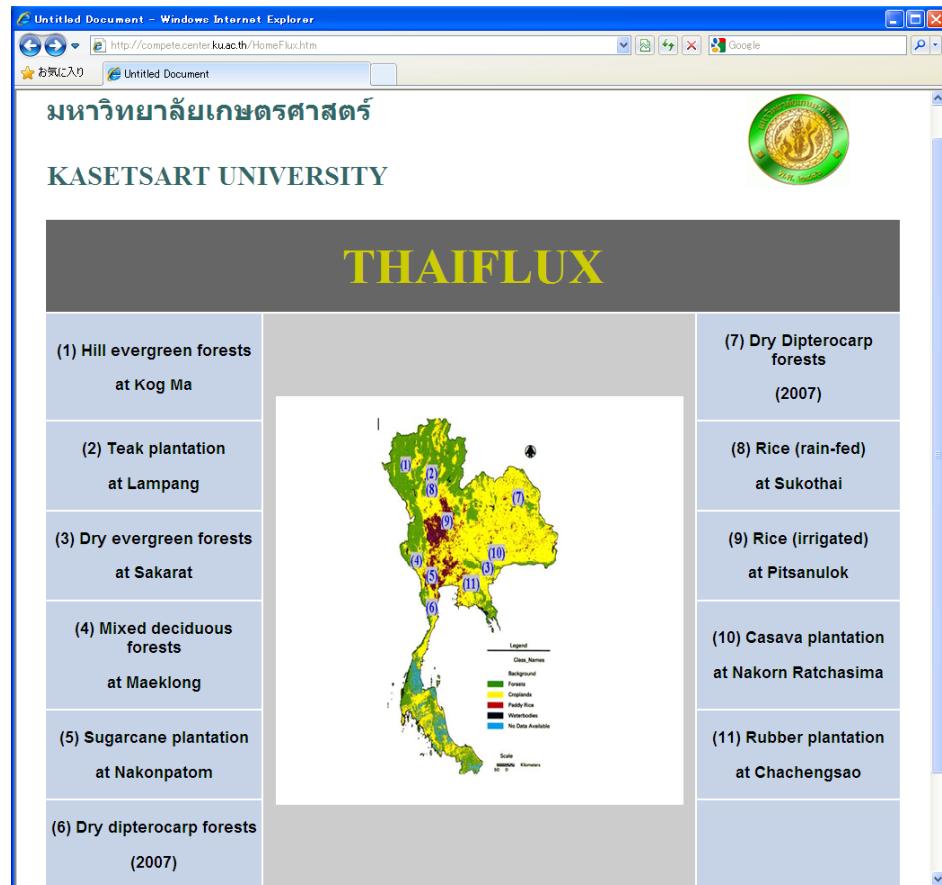
(from AsiaFlux web page)



Lien-Hua-Chih (蓮華池)



# Member network ThaiFlux



<http://compete.center.ku.ac.th/HomeFlux.htm>

## International Workshop on Flux Estimation over Diverse Terrestrial Ecosystems in Asia -AsiaFlux Workshop 2006-



(from AsiaFlux web page)

Date: 29 November - 1 December 2006

Venue: Chiang Mai, Thailand

## US-Japan Workshop on Monsoon Asia Tropical Forest Carbon Dynamics and Sustainability (Jan 8-11, 2009)



Figure 6. Workshop participants at the Sakaerat Environmental Research Station during pre-workshop field trip.  
(from APN CAPaBLE Report)



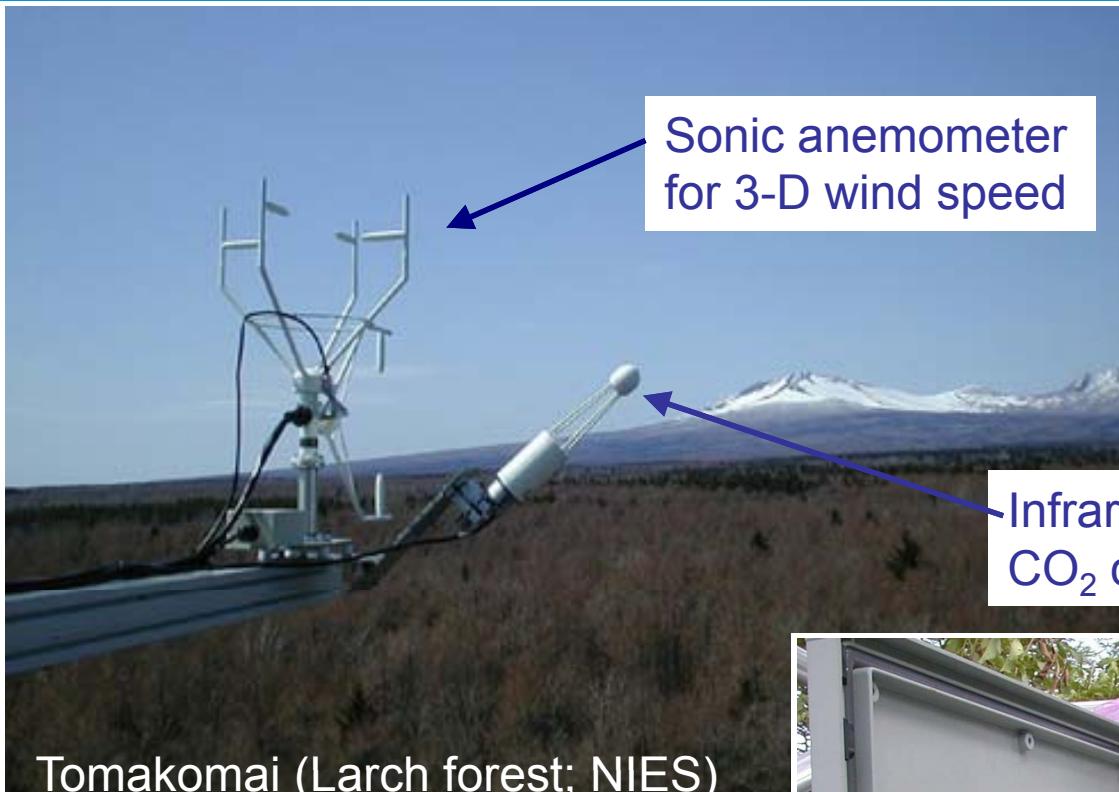
# Contents

## 1. Integrative Use of FLUXNET-AsiaFlux Network Observations

- What are FLUXNET and AsiaFlux?
- How to measure CO<sub>2</sub> uptake  
Temporal variation



# *Measuring CO<sub>2</sub> exchange between ecosystems and the atmosphere*



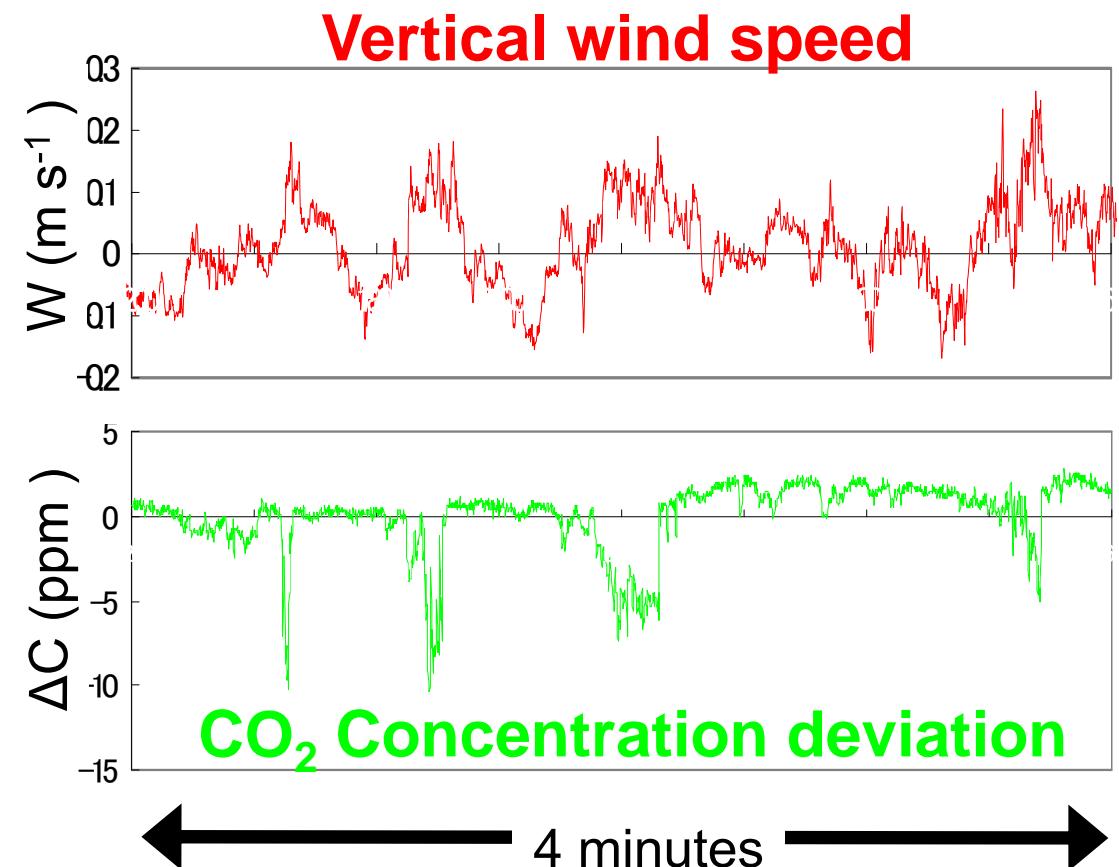
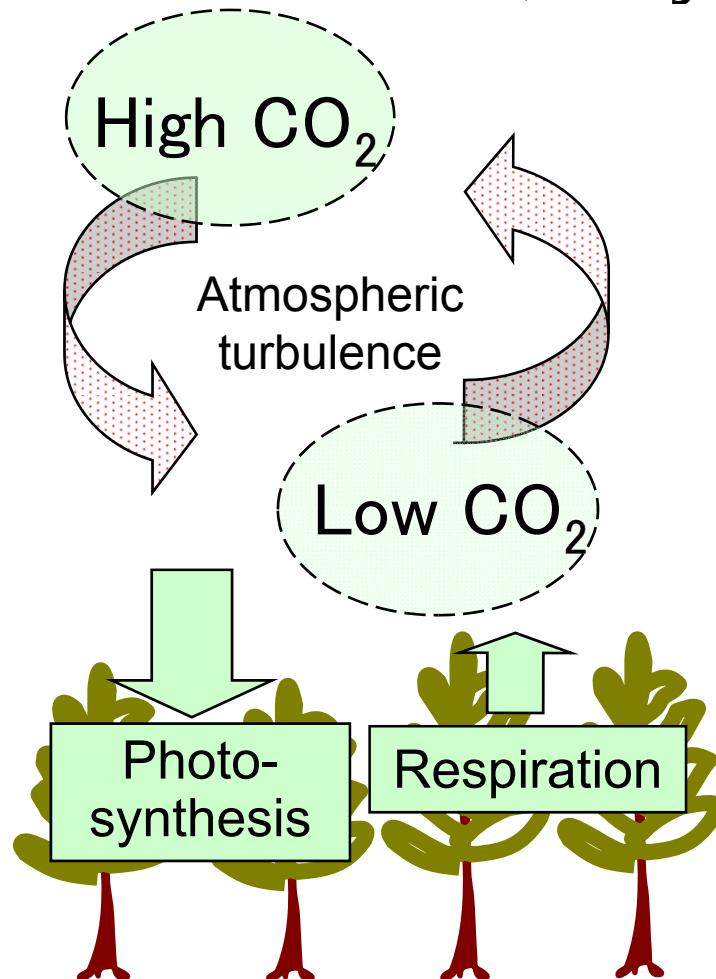
Monitoring of CO<sub>2</sub> uptake by micro-meteorological method

Tomakomai (Larch forest; NIES)

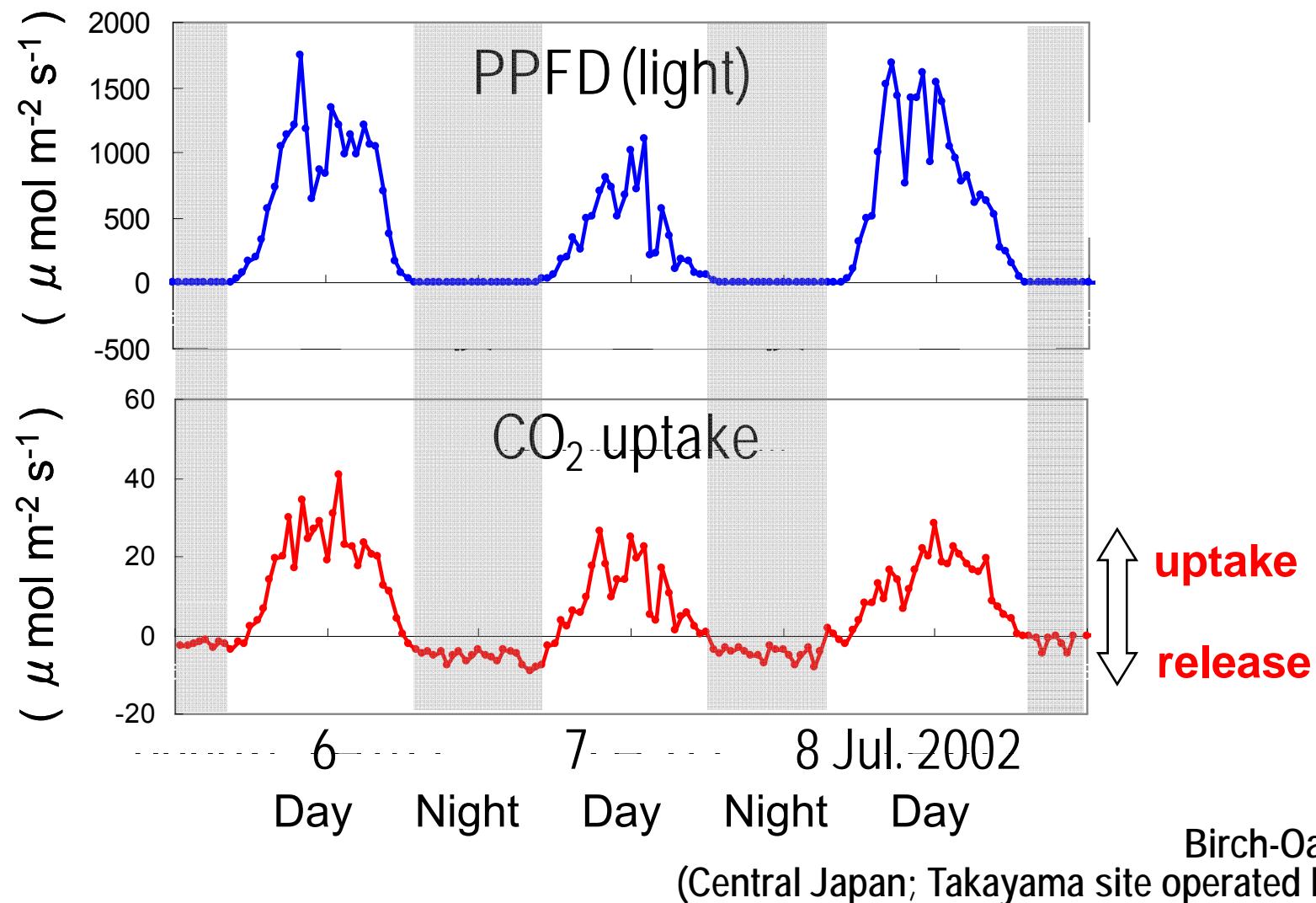
Data logger



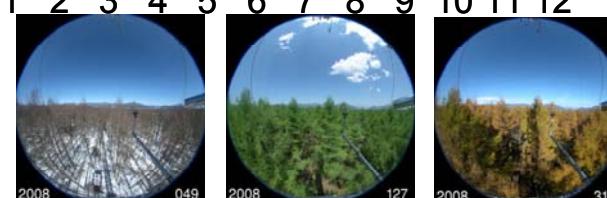
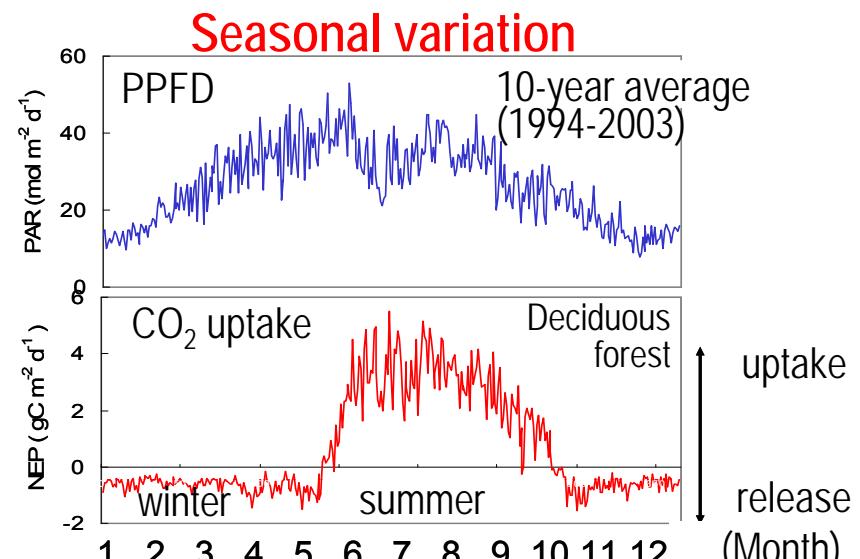
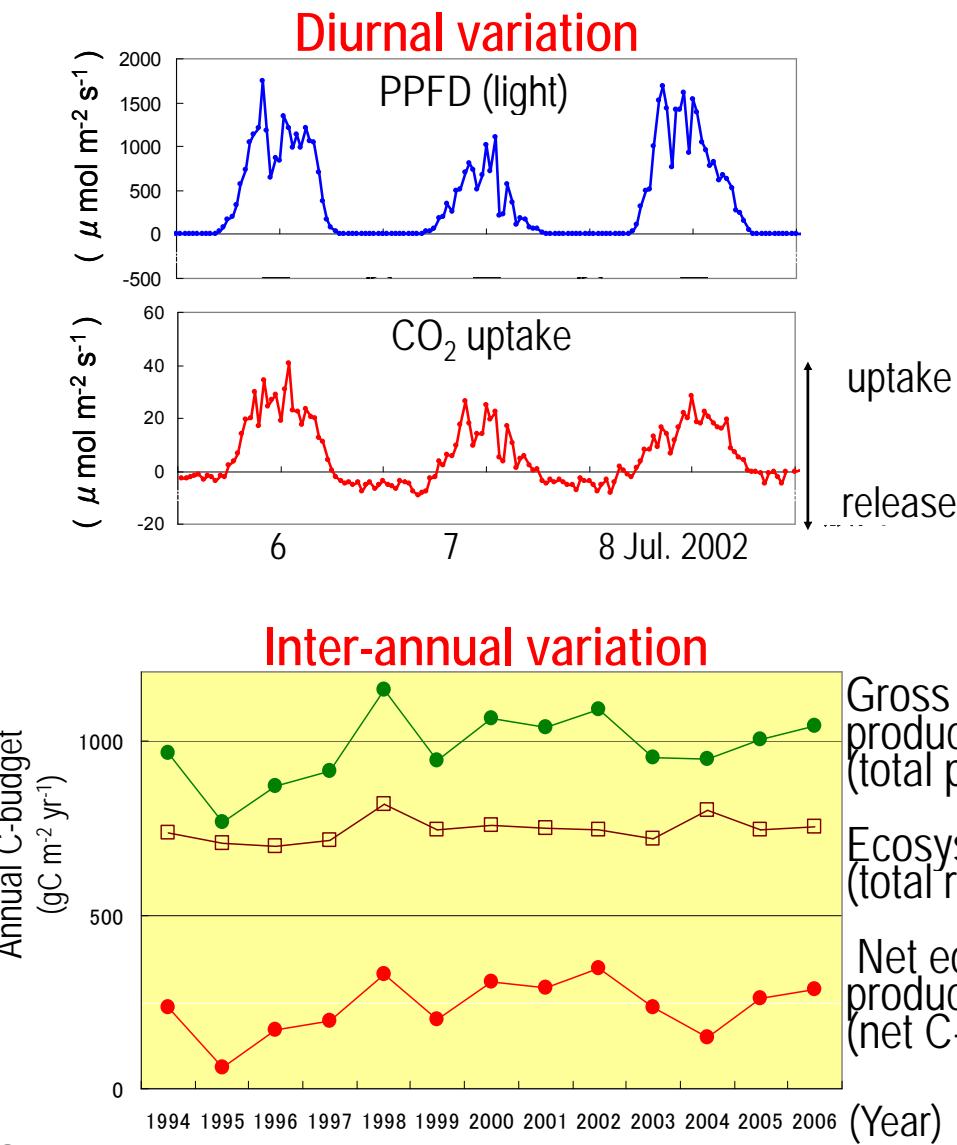
# Monitoring of CO<sub>2</sub> uptake by micro-meteorological (Eddy covariance) method



Net  $\text{CO}_2$  uptake ← every half hour



## Long-term temporal variations of C-budget





# Contents

## 1. Integrative Use of FLUXNET-AsiaFlux Network Observations

- What are FLUXNET and AsiaFlux?

- How to measure CO<sub>2</sub> uptake

Temporal variation

Effect of disturbance

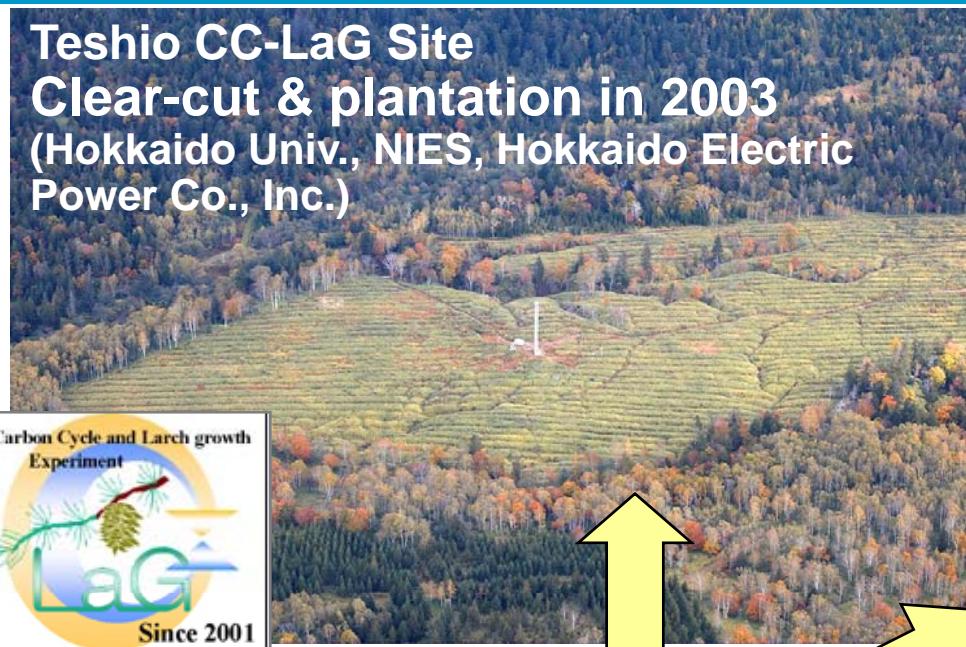


# Monitoring CO<sub>2</sub> uptake after artificial disturbance

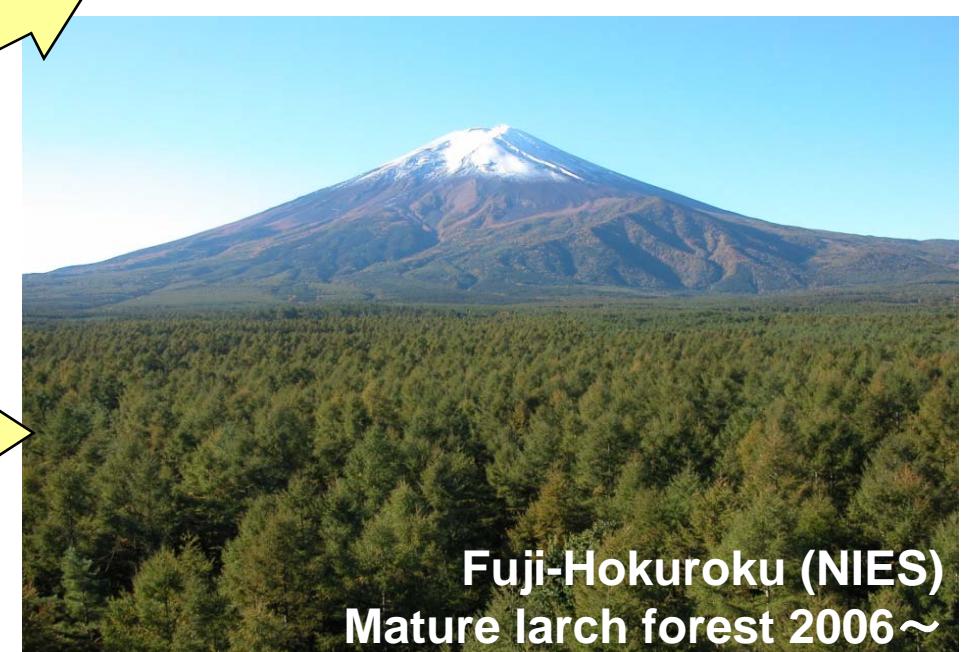
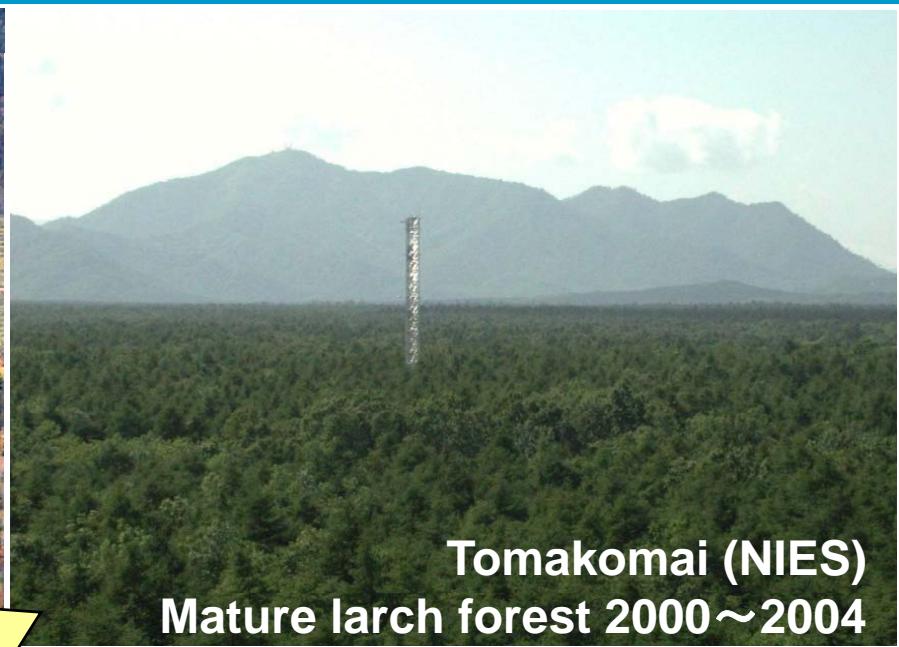
Teshio CC-LaG Site

Clear-cut & plantation in 2003

(Hokkaido Univ., NIES, Hokkaido Electric Power Co., Inc.)



Larch: deciduous conifer

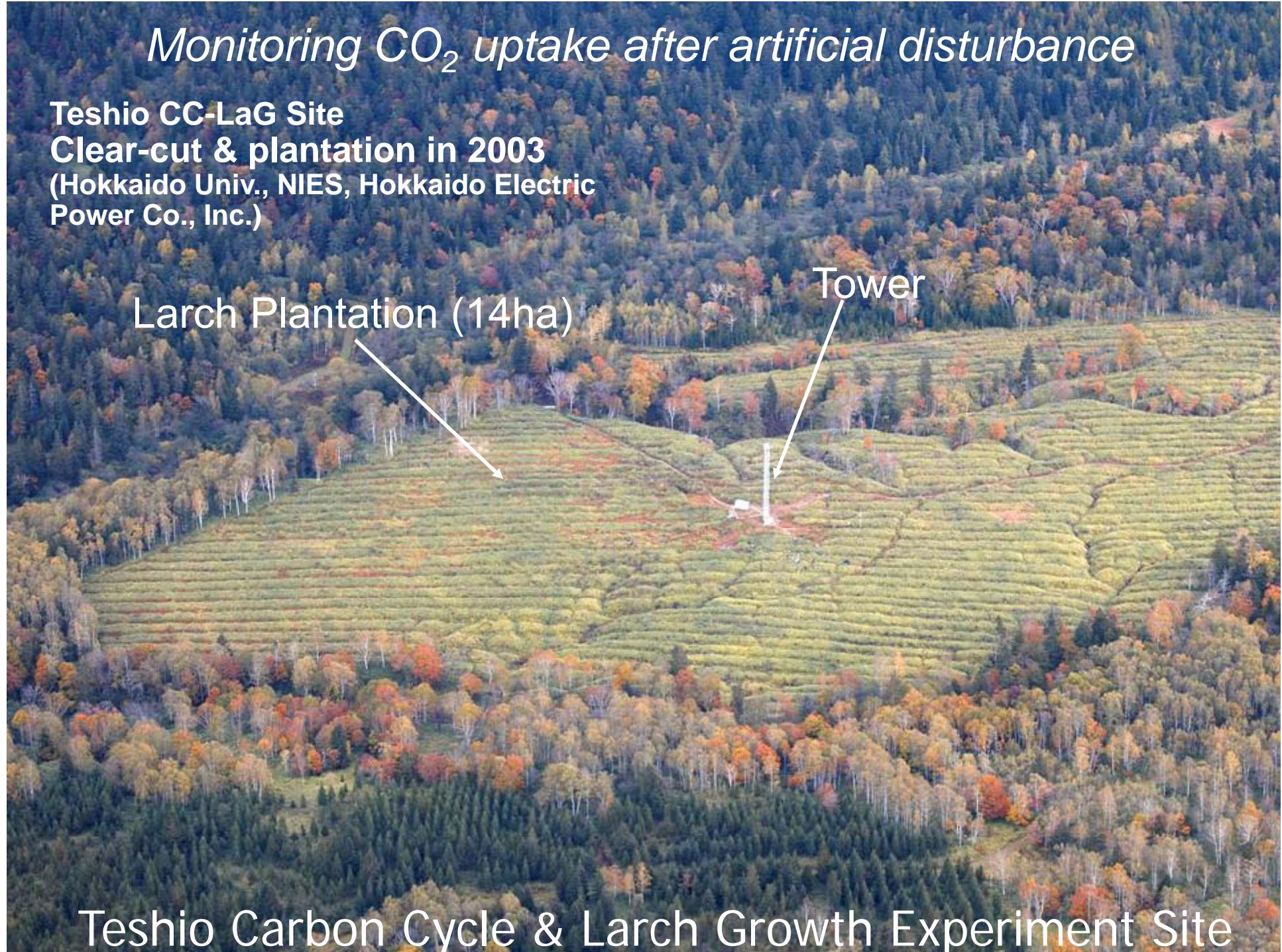


JaLTER



# *Monitoring CO<sub>2</sub> uptake after artificial disturbance*

**Teshio CC-LaG Site**  
**Clear-cut & plantation in 2003**  
**(Hokkaido Univ., NIES, Hokkaido Electric  
Power Co., Inc.)**

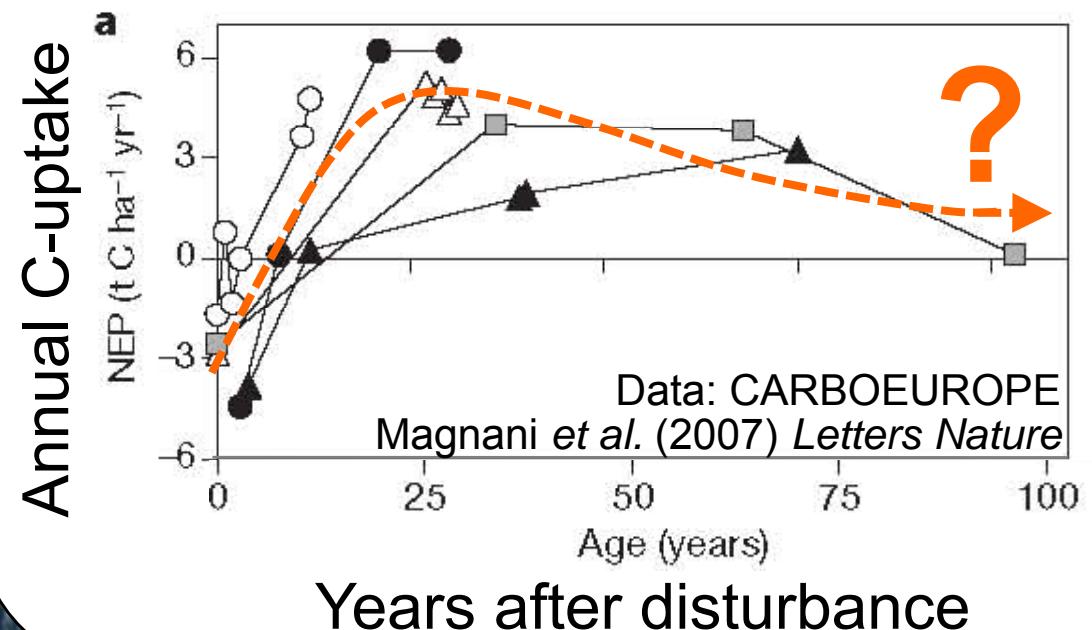


# Monitoring CO<sub>2</sub> uptake after artificial disturbance

Teshio CC-LaG Site  
Clear-cut & plantation in 2003  
(Hokkaido Univ., NIES, Hokkaido Electric  
Power Co., Inc.)

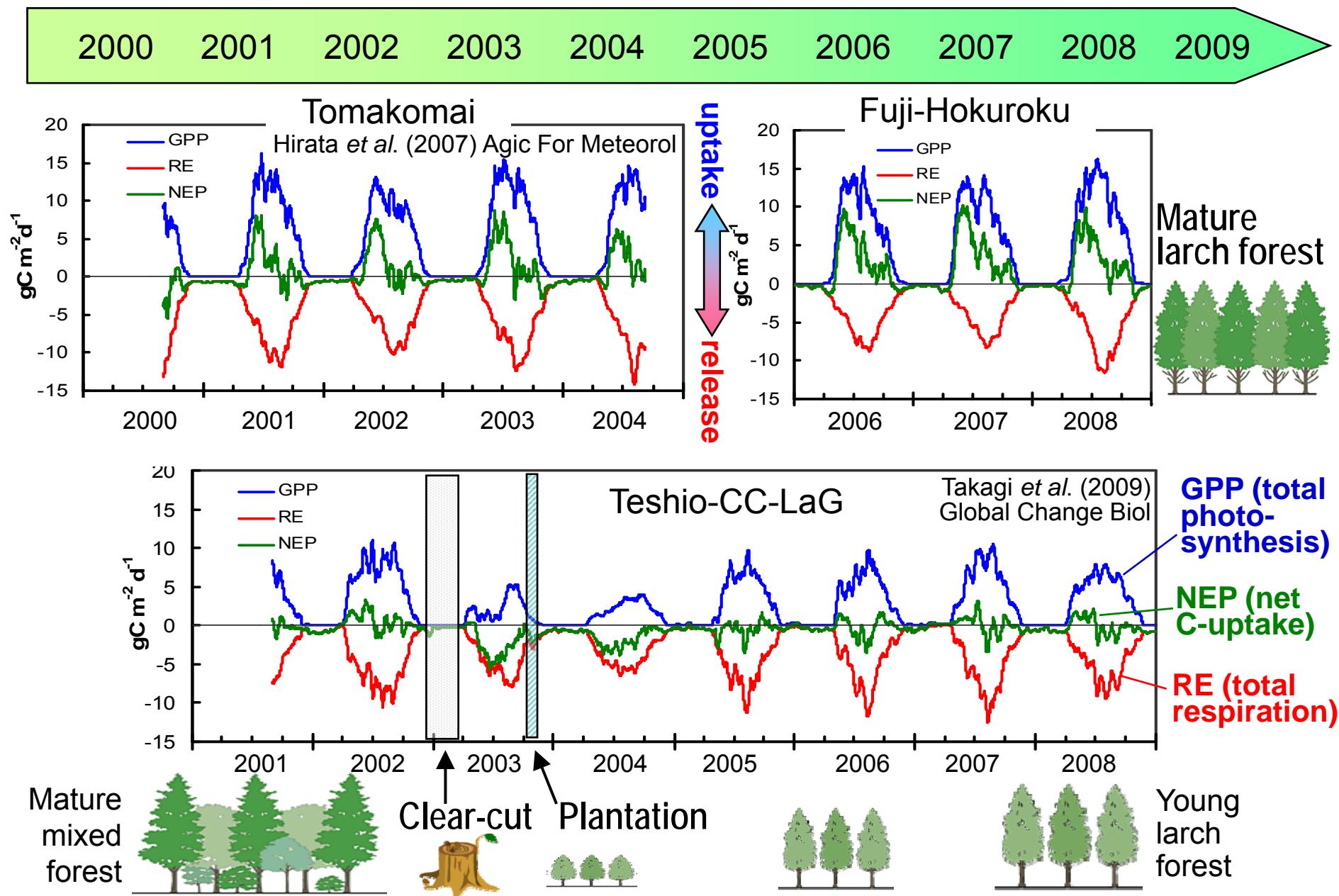
Larch Plantation (1)

How does the C-uptake rate change  
with the years after disturbance?



Teshio Carbon Cycle & Larch Growth Experiment Site

# Monitoring CO<sub>2</sub> uptake after artificial disturbance





# Contents

## 1. Integrative Use of FLUXNET-AsiaFlux Network Observations

- What are FLUXNET and AsiaFlux?
- How to measure CO<sub>2</sub> uptake

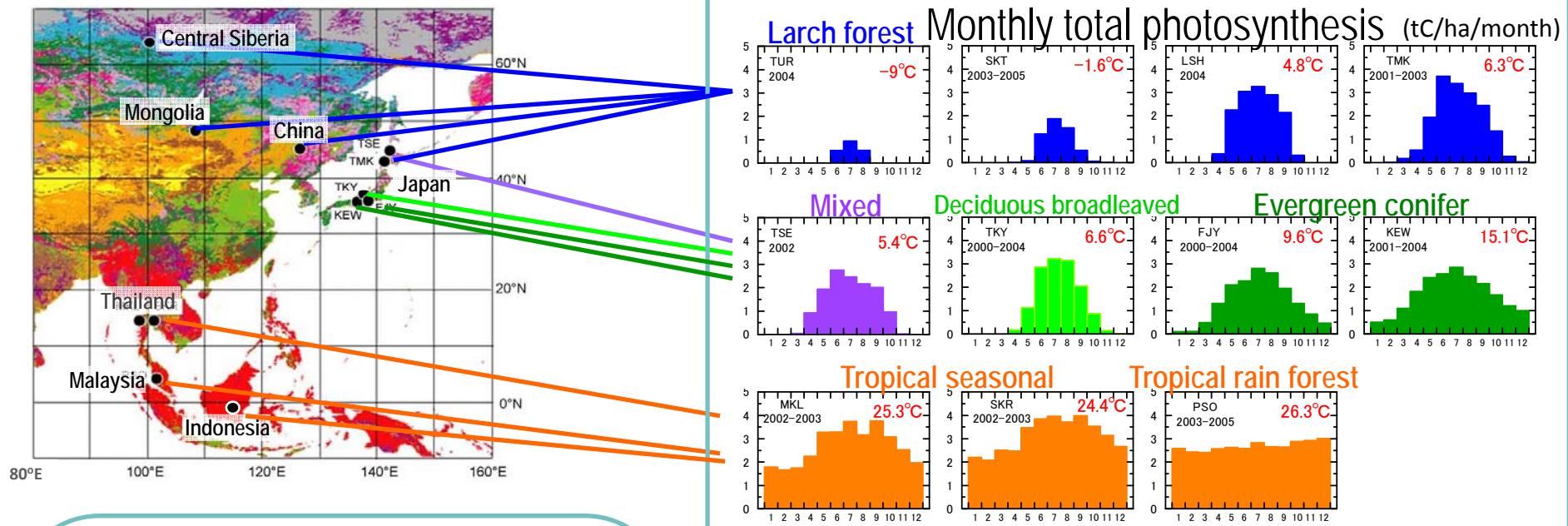
Temporal variation

Effect of disturbance

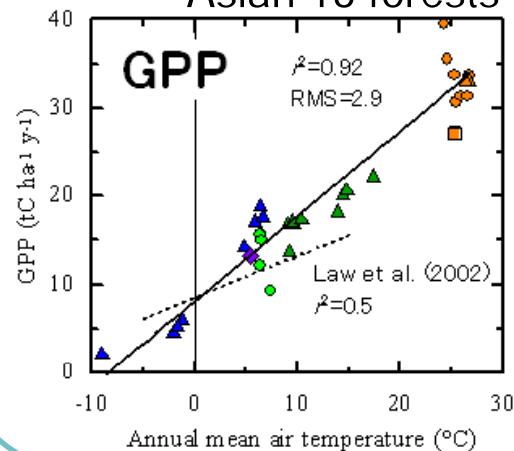
Spatial distribution



# Spatial distribution of C-budget in Asian forests

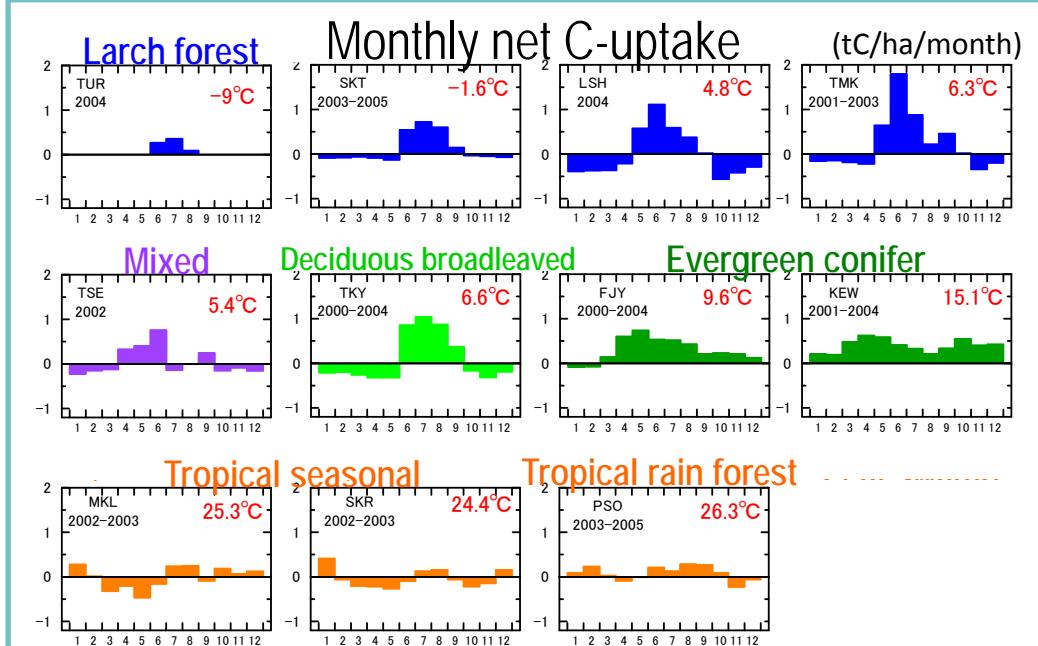


Temperature dependence of annual total photosynthesis in Asian 13 forests



Hirata et al.  
(2008) Agric For Meteorol

Saigusa, et al. (2008) Agric For Meteorol





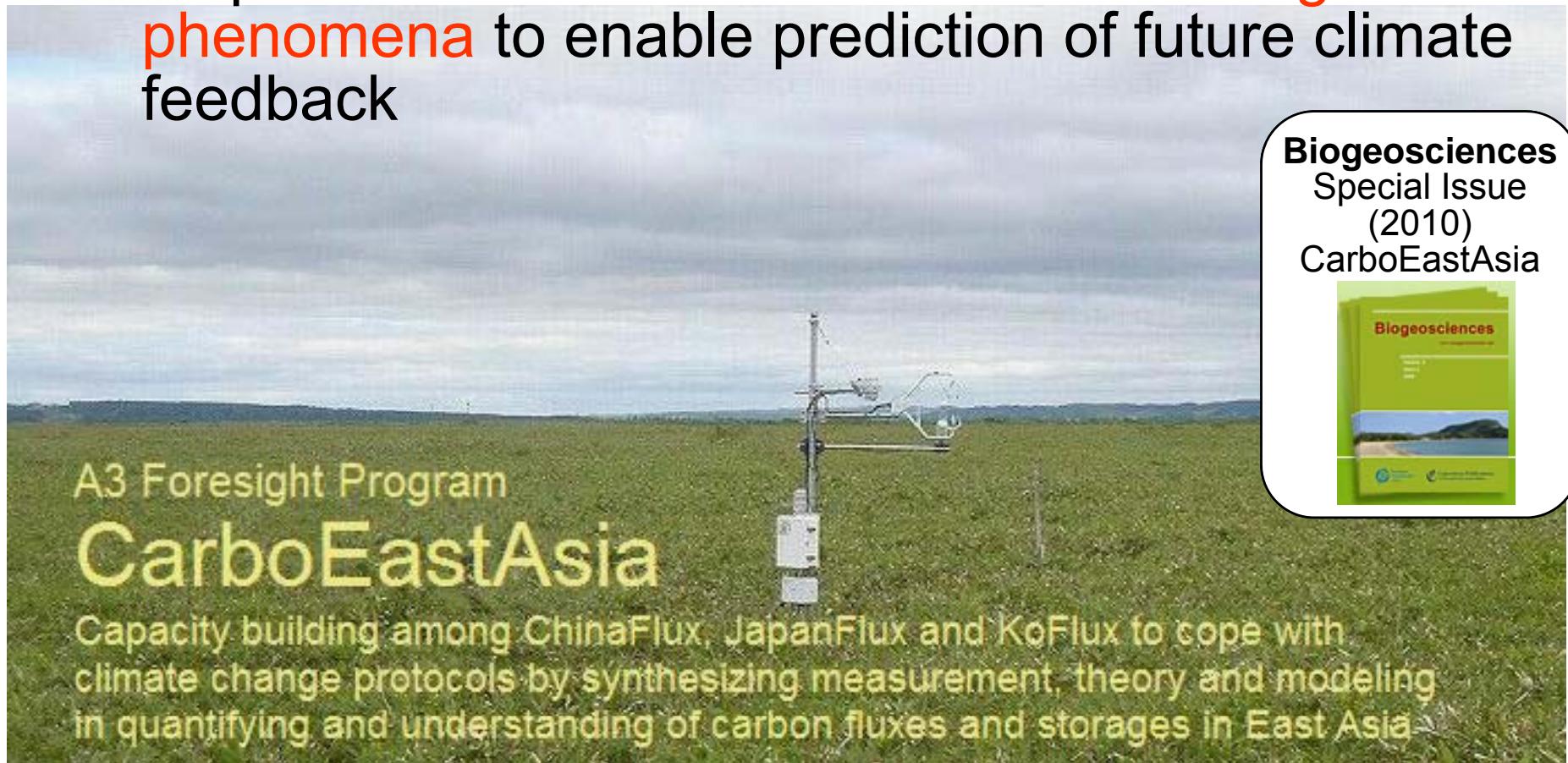
# Contents

- 1. Integrative Use of FLUXNET-AsiaFlux Network Observations**
  
- 2. Continental-scale Estimates of Carbon Budget**



# Impact of meteorological anomalies on productivity in East Asia

To gain understandings in dynamic ecosystem responses to **continental-scale meteorological phenomena** to enable prediction of future climate feedback



Supported by JSPS (Japan), NSFC (China) & KOSEF (Korea)

<http://www.carboeastasia.org/>

# **Impact of meteorological anomalies on productivity in East Asia**

## **Data:**

### **1. CO<sub>2</sub> flux observed at AsiaFlux forest sites**

- Larch forest (Mongolia, China, Japan)
- Pine forest (China)
- Mixed forest (China, Japan)      light
- Birch-Oak forest (Japan)

### **2. Spatial distribution of PPFD estimated by satellite images**

- MODIS (Terra & Aqua), SeaWiFS (Sea star)
- 2001-2006, 1-day average, 25km resolution (Frouin & Murakami, 2007)
- Calibrated by Buoys & AsiaFlux sites      Total C-uptake

### **3. Spatial distribution of modeled GPP (total photosynthesis) calibrated by AsiaFlux datasets**

- Support Vector Machine (Yang et al., 2007)
- 2001-2006, 8-day average, 8km resolution
- Input & test data: AmeriFlux, AsiaFlux

# Impact of meteorological products

## Data:

### 1. CO<sub>2</sub> flux observed at

- Larch forest (Mongolia, China)
- Mixed forest (China, Japan)

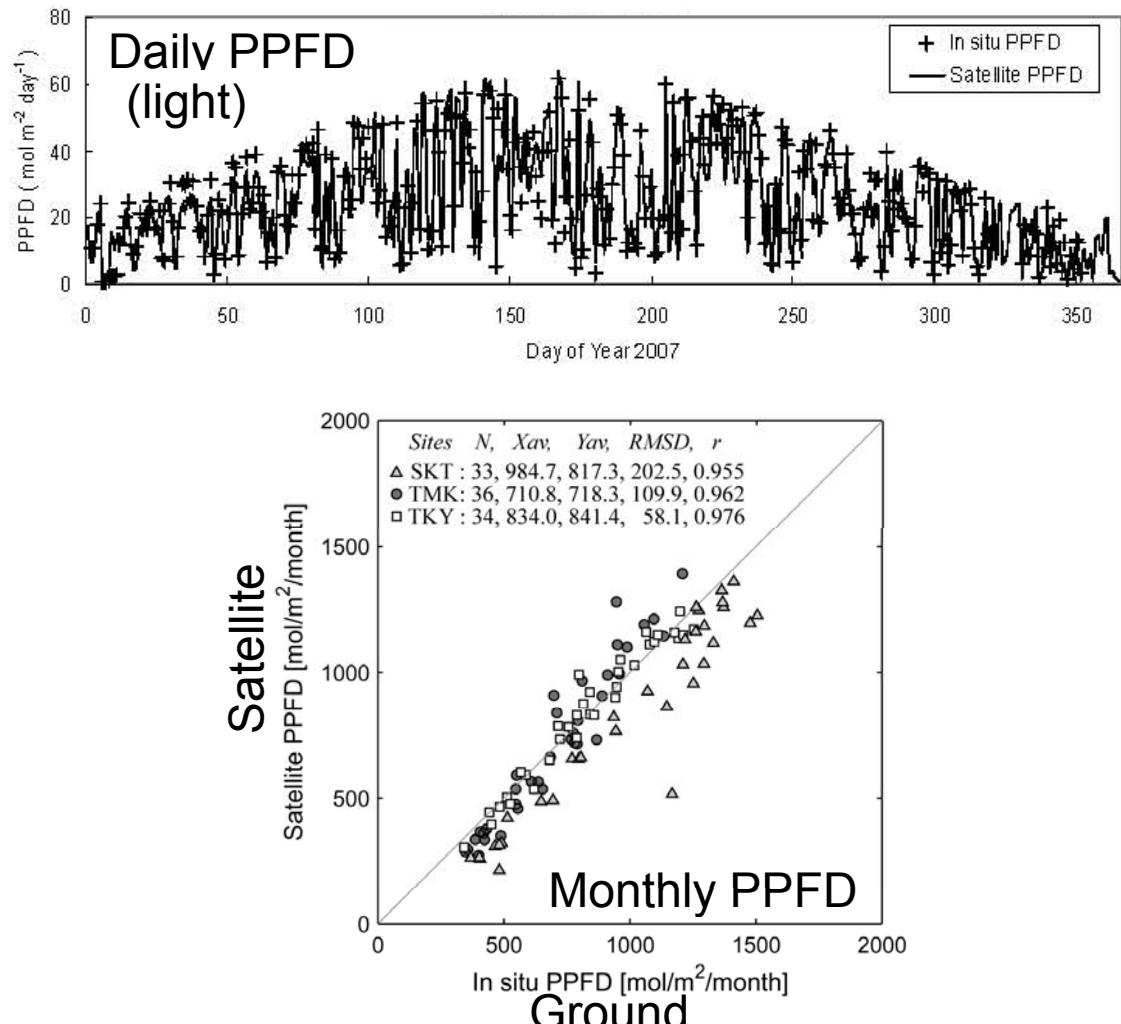
### 2. Spatial distribution of

- MODIS (Terra & Aqua), Satellite
- 2001-2006, 1-day average
- Calibrated by Buoys & AsiaFlux

### 3. Spatial distribution of

- calibrated by AsiaFlux
- Support Vector Machine (SVM)
- 2001-2006, 8-day average
- Input & test data: AmeriFlux

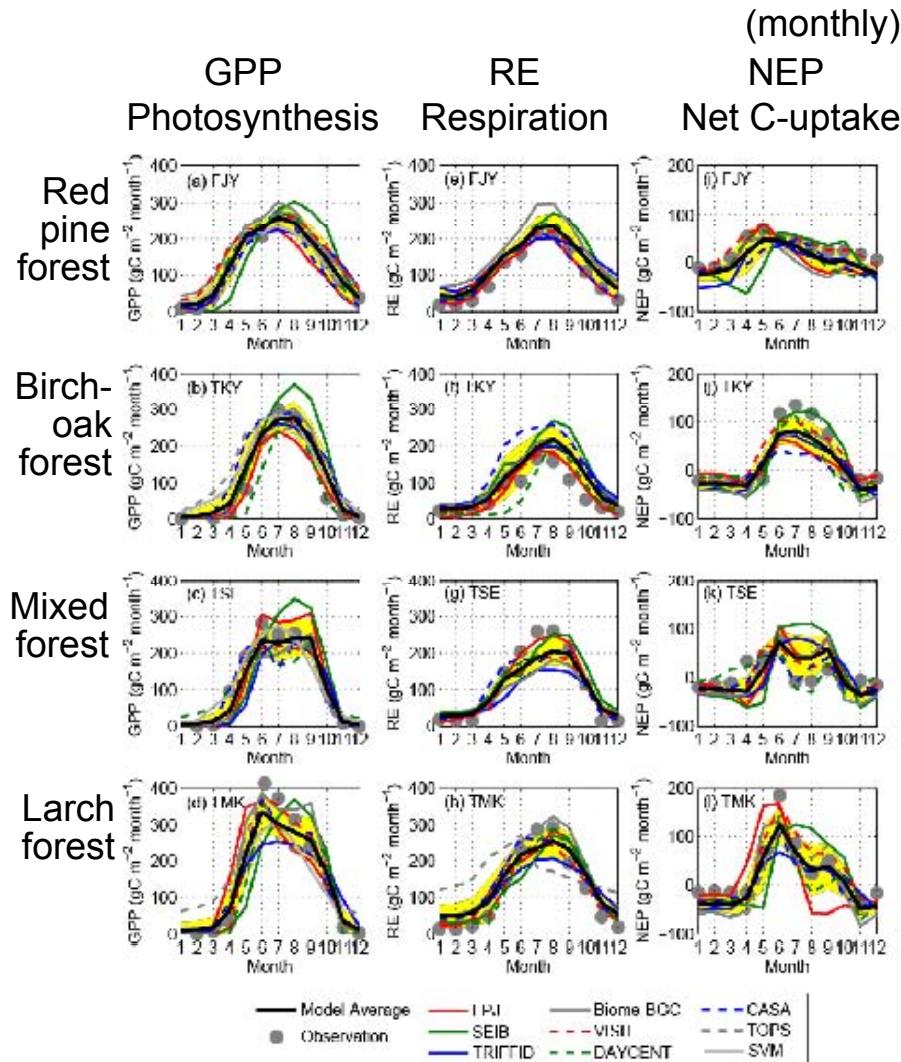
## Validation of satellite-PPFD by AsiaFlux ground data



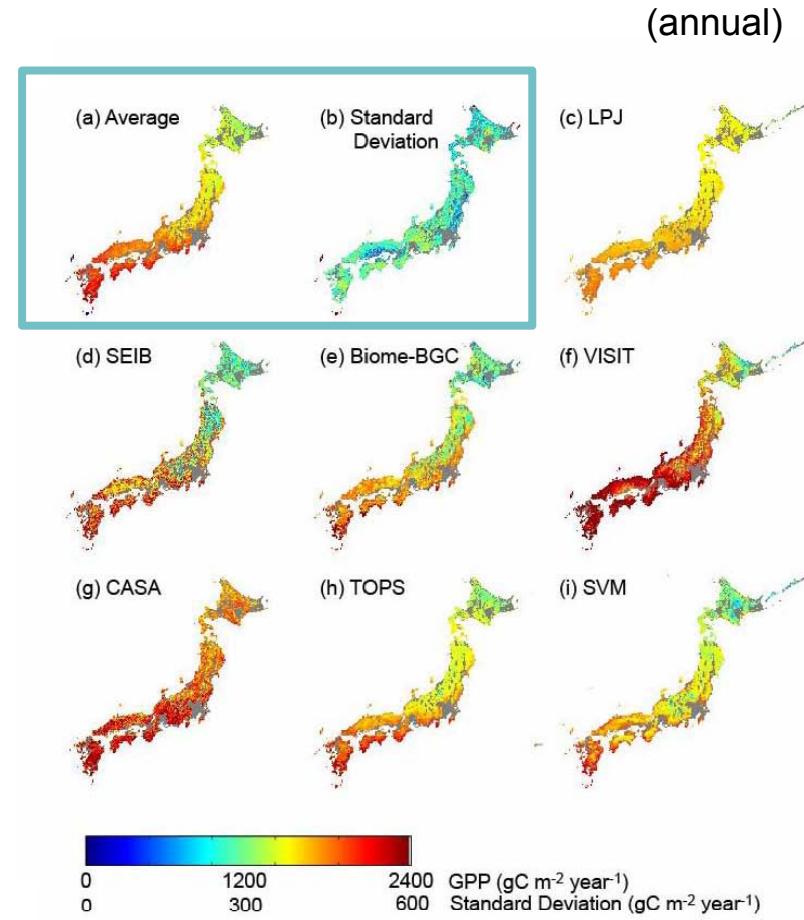
Satellite PPFD(JAXA/EORC)  
<http://kuroshio.eorc.jaxa.jp/JASMES/>

# Inter-comparison among terrestrial ecosystem models and calibration using AsiaFlux Data

## Temporal variation



## Spatial distribution



Ichii et al. (2010) *Biogeosciences*

# Abnormal weather in the 2003 summer

Europe: highest temp.  
in the past 100 years  
(UNEP)

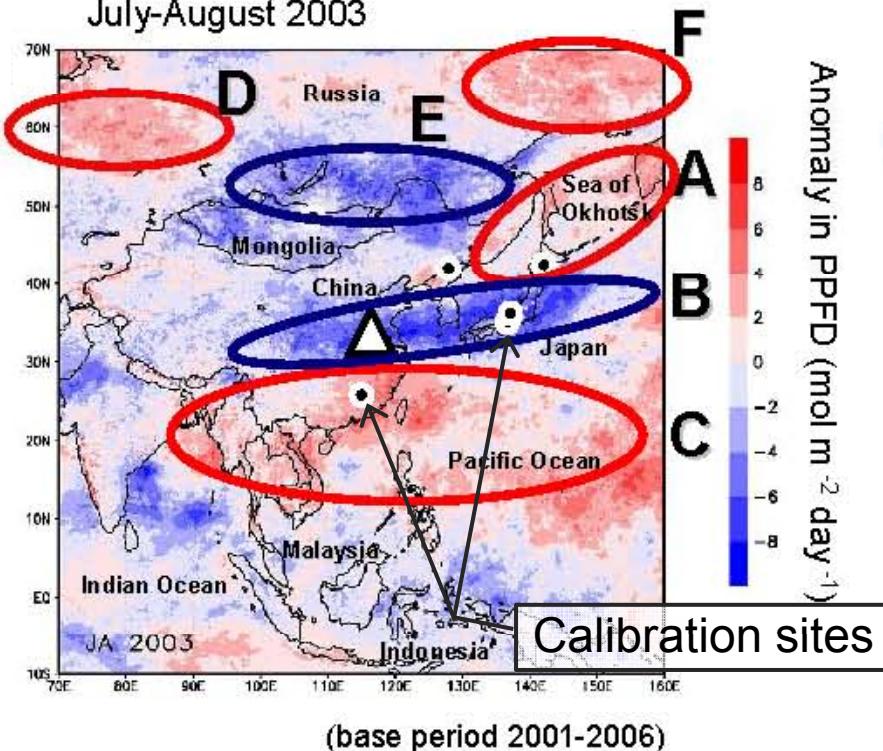
European Russia:  
cold & heavy rain

West Siberia: one of  
the highest temp. in 100  
years (METEO RU)

NE Japan: sunshine  
hours 40% of normal  
year (JMA)

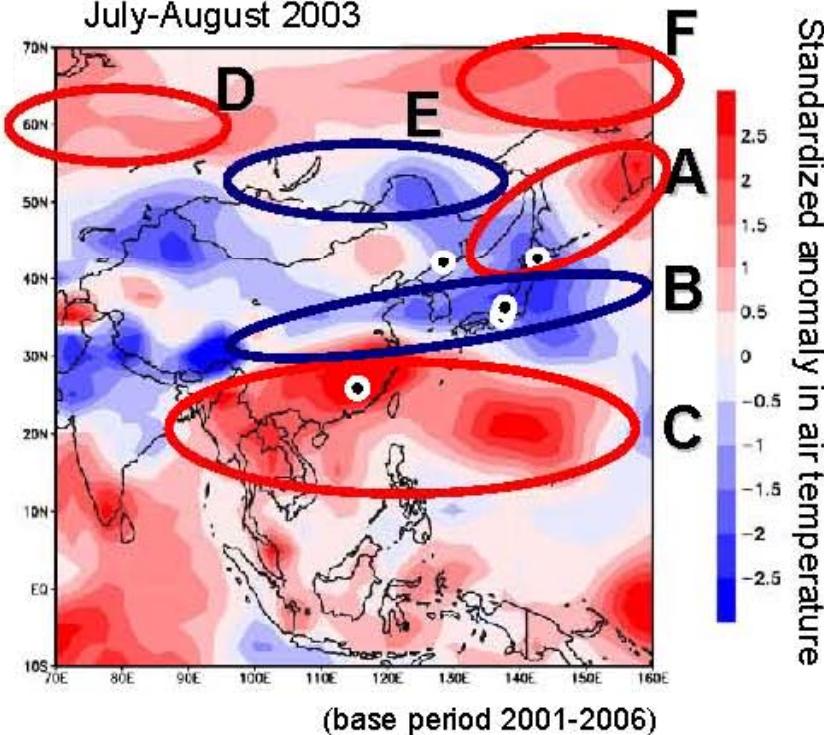
PPFD (light) anomaly

July-August 2003



Air temperature anomaly

July-August 2003



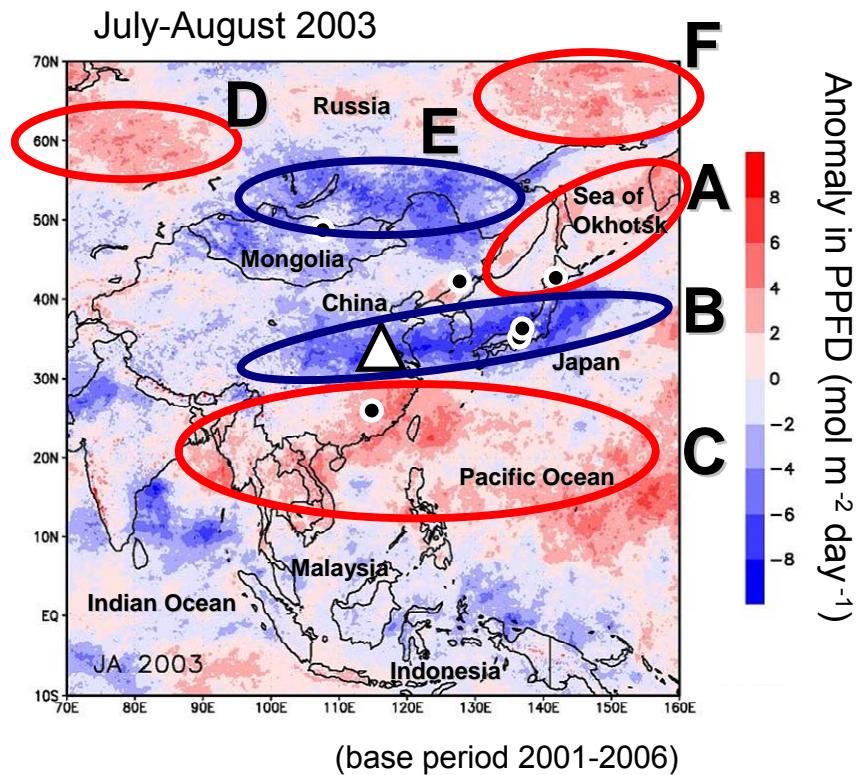
- MODIS (Terra & Aqua), SeaWiFS (Sea star)
- 2001-2006, 1-day average, 25km resolution (Frouin & Murakami, 2007)
- Calibrated by Buoys & AsiaFlux sites

Standardized anomaly estimated  
from NCEP/NCAR reanalysis data  
(Kistler *et al.*, 2001),

Saigusa *et al.* (2010) *Biogeosciences*

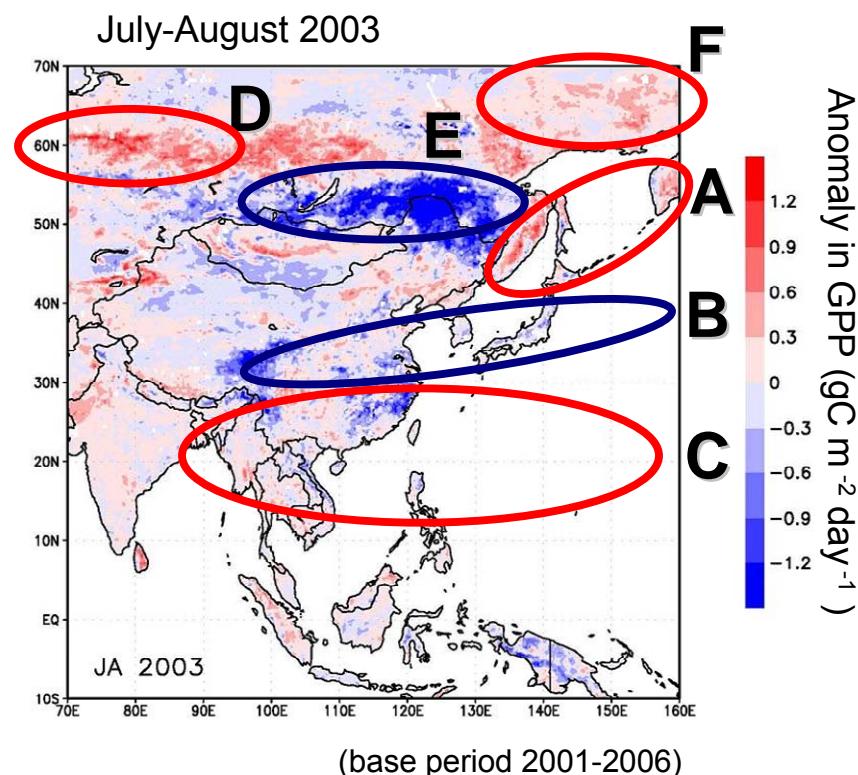
# Spatial distribution of the anomalies in the 2003 summer

PPFD (light) anomaly



- MODIS (Terra & Aqua), SeaWiFS (Sea star)
- 2001-2006, 1-day average, 25km resolution (Frouin & Murakami, 2007)
- Calibrated by Buoys & AsiaFlux sites

GPP (total photosynthesis) anomaly

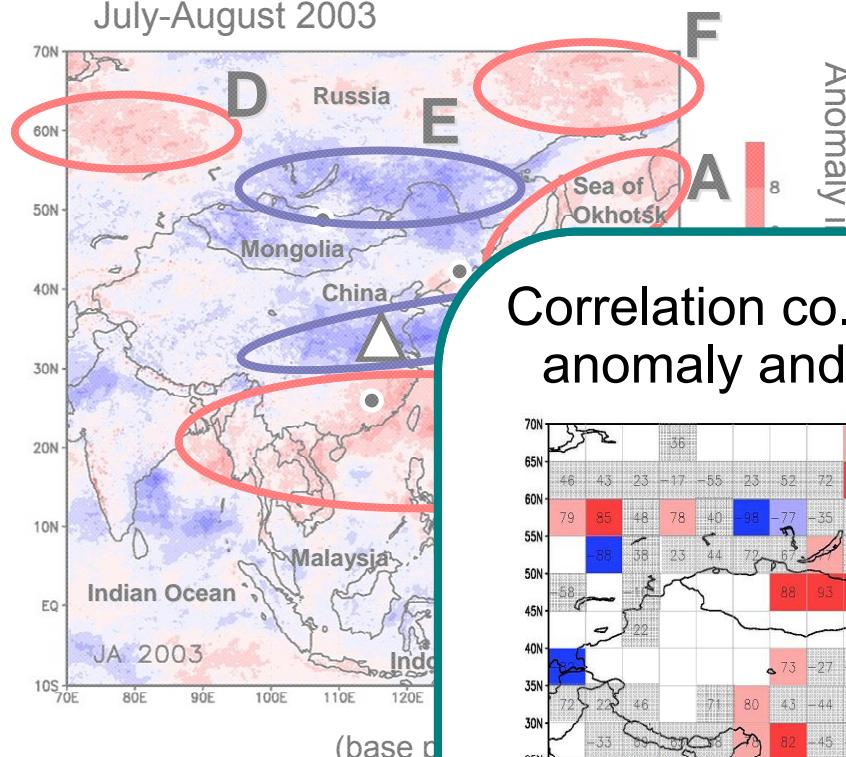


- Support Vector Machine (Yang et al., 2007)
- 2001-2006, 8-day average, 8km resolution
- Input & test data: AmeriFlux, AsiaFlux

# Spatial distribution of the anomalies in the 2003 summer

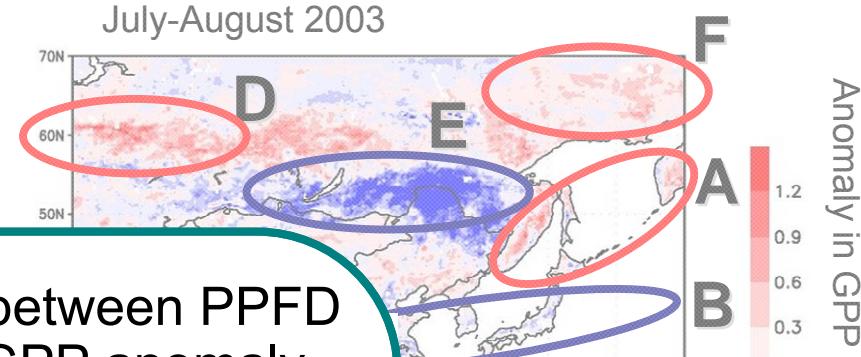
PPFD (light) anomaly

July-August 2003

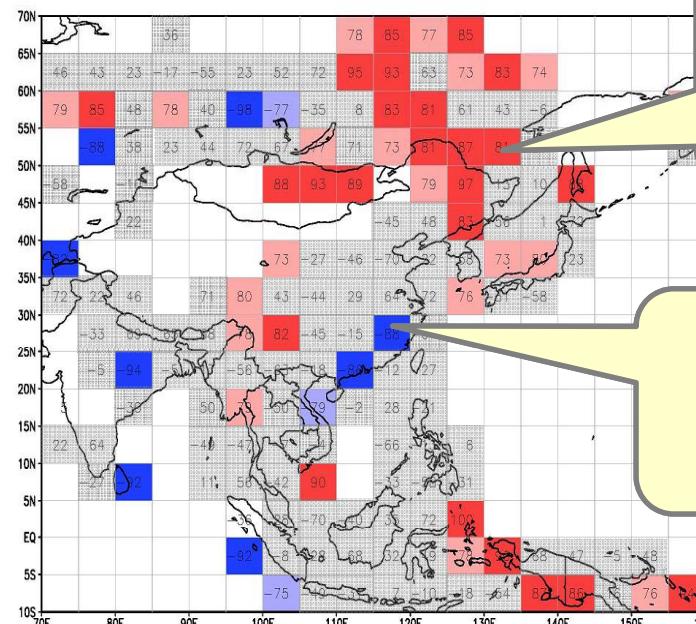


GPP (total photosynthesis) anomaly

July-August 2003



Correlation co. between PPFD anomaly and GPP anomaly



Red: radiation controls productivity

Blue: other factors (drought) control productivity

- MODIS (Terra & Aqua), S
- 2001-2006, 1-day average (Frouin & Murakami, 200
- Calibrated by Buoys & A



# Contents

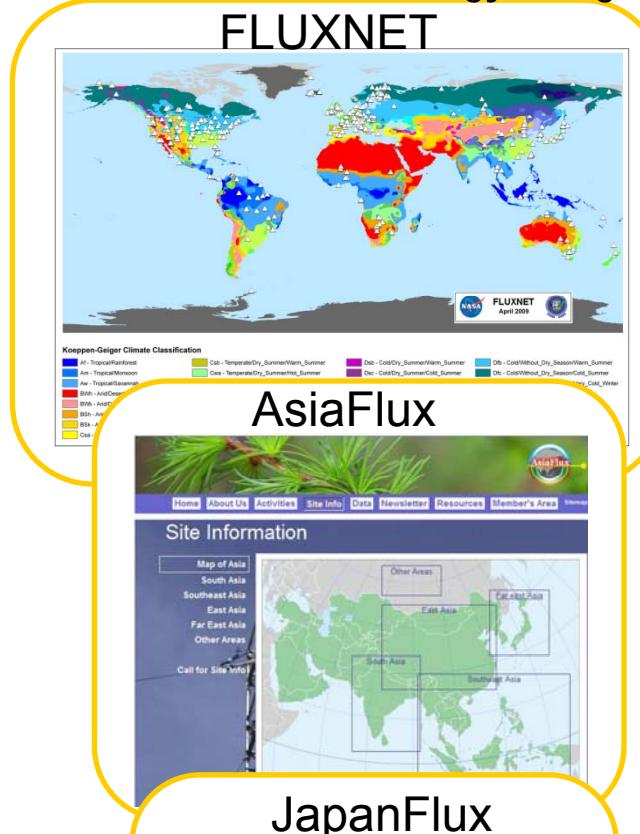
- 1. Integrative Use of FLUXNET-AsiaFlux Network Observations**
- 2. Continental-scale Estimates of Carbon Budget**
- 3. Needs and the Next Step**



# Needs and the next step

## (1) Networking interdisciplinary ground observations

Carbon, water and energy budget

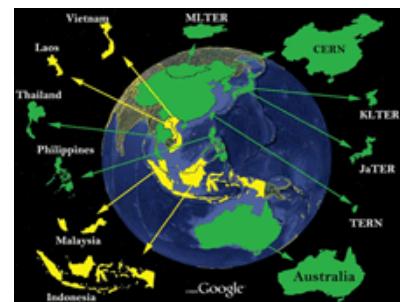


JapanFlux

International Long Term Ecological Research (ILTER)



ILTER Asia-Pacific Network  
ILTER-EAP



JaLTER

Monitoring sites  
1000 (MOE)

Radiation and aerosol observation network

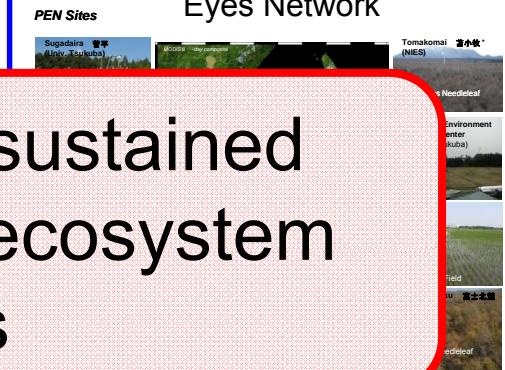
**SKYNET**



<http://atmos.cr.chiba-u.ac.jp/>

Phenology monitoring

Phenological Eyes Network

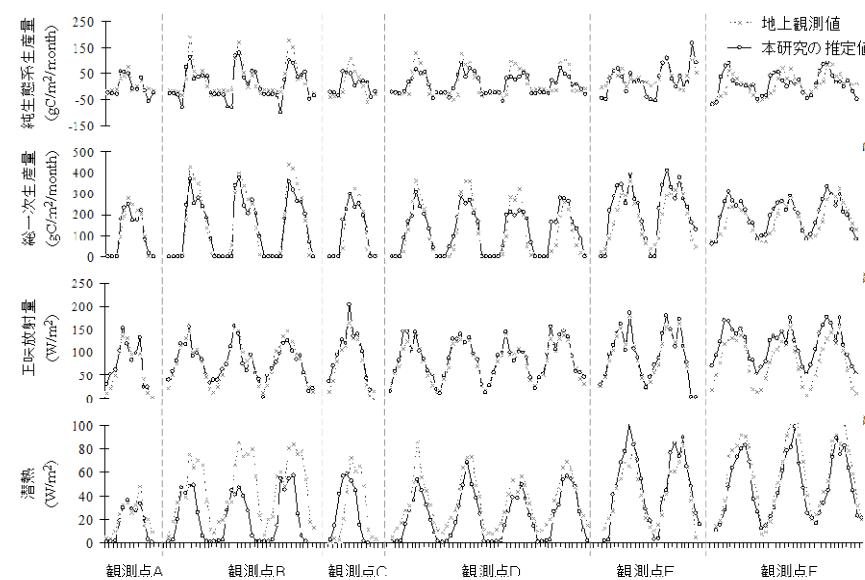


Comprehensive, coordinated and sustained terrestrial monitoring for long-term ecosystem responses and feedbacks

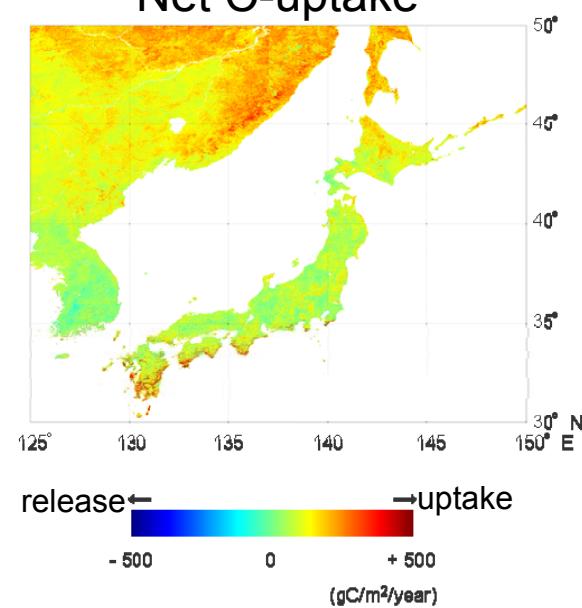
## Needs and the next step (2) Optimization of parameters for near real-time monitoring

Monitoring of regional C-budget by integration of ground-based and satellite observations and optimization of model parameters

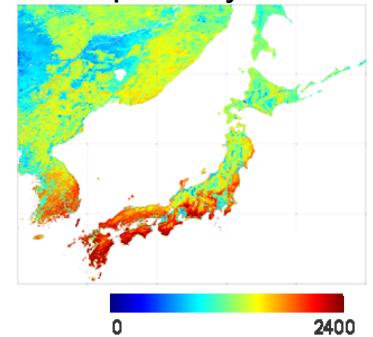
Validation of carbon and water budgets using AsiaFlux dataset



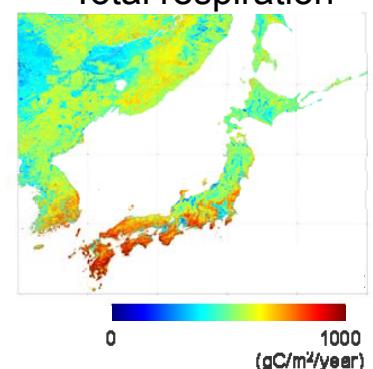
C-budget estimation in Japan  
Net C-uptake



Total photosynthesis

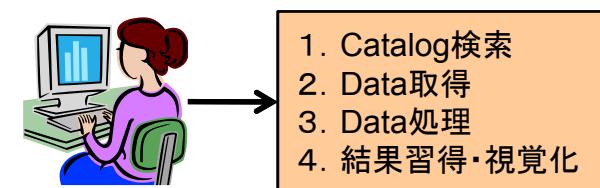


Total respiration



# Asia GEO Grid Initiative

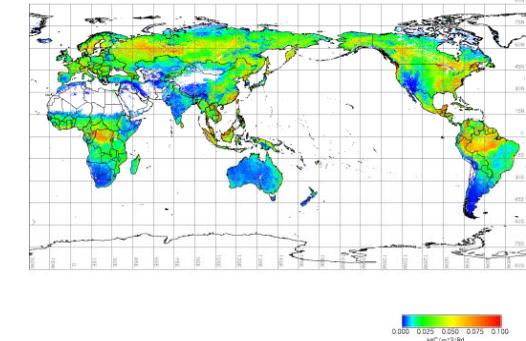
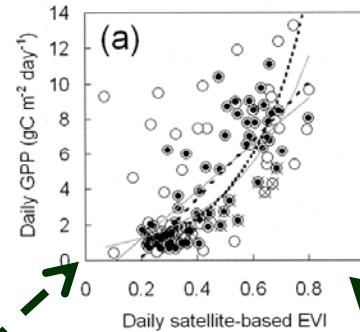
(Led by Tanaka Y, AIST)



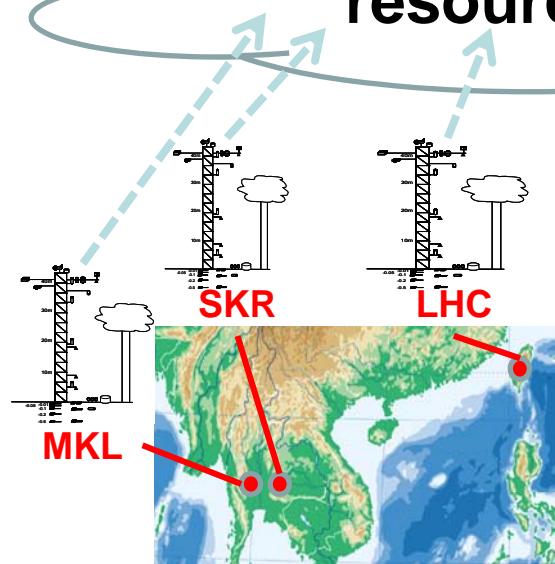
## Integrative use of flux data & satellite images

Calibration of satellite -based GPP using ground data

**CO<sub>2</sub> budget calibrated by ground datasets**

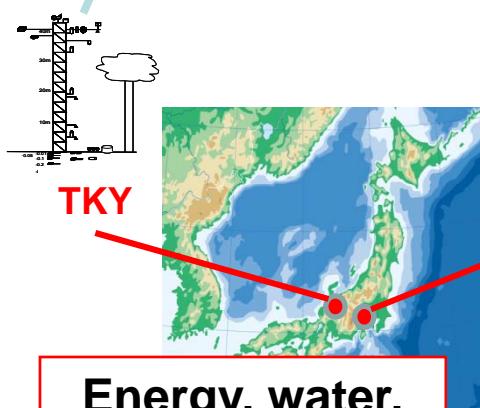


**GEO GRID: Sharing database and computer resources for Earth Observation in Asia**

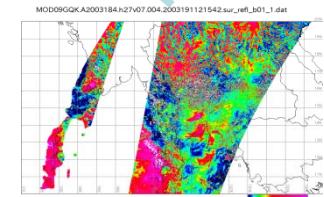
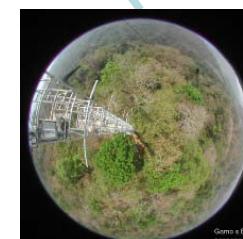


Flux sites in Asia

Energy, water,  
CO<sub>2</sub> flux data



Automatic  
digital  
fisheye camera



Spectral  
reflectance  
from satellite



# Summary

1. Networking interdisciplinary ground observations has a great potential for predicting future ecosystem responses.
2. Monitoring of disturbance and recovery is vitally important for long-term ecosystem research.
3. Integrative use of network observations enables us to track dynamic variations of continental-scale ecosystem functions.

