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# AsiaFlux Newsletter

## Contents



## AsiaFlux Implementation of New Programs funded by MEXT and APN

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The 4th AsiaFlux Workshop 2005 was held in Fujiyoshida on August 24-26, 2005, with over 130 participants from 12 countries. I would like to take this opportunity to sincerely thank all of the participants and the staffs. At the beginning of the plenary session, I delivered a lecture on our new programs of AsiaFlux activities. As the programs are the first cases that have background of secure funding to support our activities directly, I would like to explain the details.

Since the establishment of AsiaFlux in 2000, we have hosted three international workshops for the advancement of a flux measurement network in Asia. We have also published a booklet on flux observations and analyses as well as 14 volumes of the AsiaFlux Newsletter to promote the exchange of information on terrestrial carbon balance studies mainly in East and South-East Asia, while an issue to secure funding had been remained.

This year, we have financial supports from two distinct projects, and AsiaFlux is now in the process of developing new programs. One is "Initiation of the next-generation AsiaFlux" by the Japanese Ministry of Education, Culture, Sports, Science and Technology (MEXT), and another is "Standardization and Systematization of Carbon-Budget Observation in Asian Terrestrial Ecosystems Based on AsiaFlux Framework" by the Asia-Pacific Network for Global Change Research (APN). The latter takes on the characteristics of a grant. Mainly the executive committee members under the former chairman, Prof. Yamamoto, have carefully prepared for both programs for past two years, and it comes along so far this year.

There are three main objectives for the MEXT project: 1) to offer training courses for flux measurements and analyses to scientists in Asia, 2) to develop a standardized portable flux observation system and flux analysis techniques for inter-comparing flux

**Table 1 Workgroups and sub-workgroups**

1) AsiaFlux General WG
   a) AsiaFlux Network Management SWG (e.g. Updating AsiaFlux directory and web page)
   b) AsiaFlux Editorial SWG (e.g. AsiaFlux Newsletter)
   c) Workshop Management SWG (e.g. AsiaFlux Workshop)
2) Measurement and Data Policy WG
   a) Measurement Support and Standardization SWG
   (e.g. Flux measurement and analysis methodology, site planning, and inter-site comparison)
   b) Database and Data Policy SWG (e.g. AsiaFlux data policy and database arrangement)
   c) Short Training Courses SWG (e.g. AsiaFlux training courses for flux measurement and analysis)

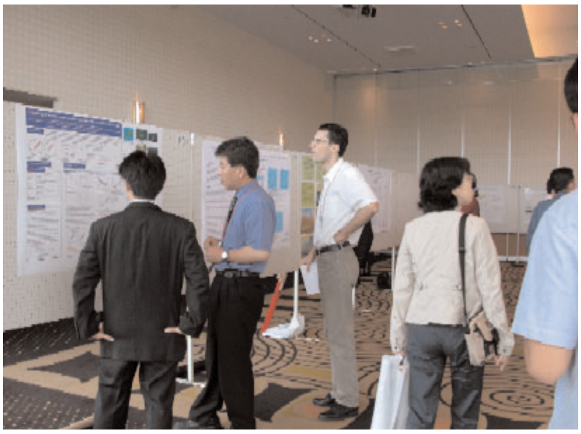

**Oral session**

measurements among the AsiaFlux sites, and 3) to establish a structure for sharing and exchanging data within and outside the AsiaFlux community. The aim of the training courses is to help scientists maintaining their local flux observational sites and analyzing data effectively. Use of the portable flux observational system and development of standardized analysis techniques will improve data accuracy. Collaborative flux observations will also take places in some terrestrial ecosystems in Asia based on the MEXT project framework. The financial support from the APN project will be spent to host workshops and to prepare manuals for the training courses which will be funded by the MEXT project.

Improving organization of AsiaFlux should be considered as important tasks to effectively implement the above-mentioned programs. For this purpose, we are planning to establish workgroups within the AsiaFlux organization. With the support from the steering and executive committees, each workgroup (Table1) plays active roles for implementing these new programs.

We believe the efforts made through the MEXT and APN projects will enhance research collaboration in Asian nations and reinforce the existing framework for research in AsiaFlux, KoFlux and the Chinese flux community, with the collaboration from OzFlux.

After the AsiaFlux Workshop 2005, we nominated leaders of each workgroup. Then, almost in tandem to the issuance of this newsletter, their work operation will be initiated and specific implementation plans will be developed. To the members of AsiaFlux, we expect your ardent participation to the workgroups as the leader's' request. We would appreciate it if you could give us your opinions about our new activities.



**Poster session**

# Report of the AsiaFlux Workshop 2005

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The AsiaFlux Workshop 2005 (International Workshop on Advanced Flux Network and Flux Evaluation) was held successfully in 24-26 August 2005, in Fujiyoshida, on the foothills of Mt. Fuji, Japan, under the condition that the large Typhoon 11 was hitting directly to our meeting. This workshop was organized by AsiaFlux Steering Committee, Forestry and Forest Products Research Institute (FFPRI, Japan) and National Institute for Environmental Studies (NIES, Japan) with founds of Ministry of Education, Culture, Sports, Science and Technology (MEXT) and Asia-Pacific Network for Global Change Research (APN). It was also gained extensive support from City of Fujiyoshida. This is the 4th workshop of the AsiaFlux network and the purpose is to provide an opportunity to improve the understanding on cycles of carbon dioxide, water vapor, and heat energy in terrestrial ecosystems. Topics included tower flux measurement, carbon cycle process models, remote sensing, general flux research, and others related terrestrial material cycle, especially carbon. Special session, "Flux measurements on complex topography" was also held in this workshop. More than 130 participants attended this meeting, including scientists and students from research institutions and universities in Australia, Bangladesh, Canada, China, Hungary, India, Japan, Korea, Malaysia, Philippines, Thailand, and USA. A small trip to Biodiversity Center of Japan, Yamanashi Institute of Environmental Sciences, Mt. Fuji, and a flux site in a Japanese red pine forest operated by FFPRI (Fig.1), was made on the last clear day of the workshop, after the Typhoon passed.

**Fig. 1 At the FFPRI Flux tower, Fujiyoshida**

## 1. New Programs of AsiaFlux and reports from Asian countries

Two funds by MEXT and APN have been approved on July 2005 for AsiaFlux activities. At the beginning of the workshop, Y. Ohtani (FFPRI), new chair of the AsiaFlux, proposed new strategies of AsiaFlux activities in the coming few years based on these funds, following the introduction of the AsiaFlux history from 2000. Please refer to the previous article on this issue.

Recent progresses in KoFlux (Korea) and ChinaFLUX (China) were introduced by J. Kim (Yonsei University) and G. Yu (Chinese Academy of Science; CAS), respectively. During the Phase I (2001-2004) of the KoFlux Program, the KoFlux team developed a global network (www.koflux.org), ensuring that KoFlux data could be collected and shared anywhere. Three of the KoFlux sites have been registered as reference sites for the GEWEX's inter project, Coordinated Enhanced Observing Period (CEOP), and the data have been submitted to the international community. During the Phase II (2004-2007), the initial 8 KoFlux sites have been reduced to 4 sites (one forest, two agricultural fields, and one prairie site in Tibet, China). Most forest and agricultural ecosystems in Korea are heterogeneous, and the application of conventional eddy covariance technique has been a difficult challenge for data collection, processing and analysis. The second phase ("Carbo/HydroKorea") focuses on linking flux footprint, eco-hydrological models and satellite image to bridge the gaps between different scales of carbon/water exchange processes in a complex landscape. For this purpose, they re-defined a forested watershed site (Gwangneung flux site) as the super site.

The Chinese progress in establishing the flux network is remarkable. Ten ChinaFLUX sites have been operated for two years, and 6 sites are under construction enhanced by CAS (Fig. 2). Most of these sites are designated as sites of the Chinese Ecosystem Research Network (CERN). In addition, Chinese Academy of Meteorological Sciences (CMA) has started the flux observation program at some of the meteorological station, already working as routine meteorological stations. The flux measurement and data processing are operated by several institutes of CMA distributed all over China. They planed to establish 9 flux sites by the end of this year (2005). Furthermore, other flux sites are planned by Department of Science and Technology State Forestry Administration, China in some of the Chinese Forest Ecosystem Research Network (CFERN) sites. Although most of the ChinaFLUX sites were established 2 years ago, the network fulfills its function led by CAS. The quality control and assurance of the flux data are operated systematically, and database construction is in progress. As of KoFlux strategy, ChinaFLUX intends to integrate the data from many flux sites, some of them are in a terrestrial transect of GCTE/IGBP, and to link the flux footprint, eco-hydrological models and satellite image to discuss the large scale materials (carbon, water, nitrogen, and phosphorus) dynamics.

Reports from other 4 countries in Asia were presented, and future research plan and the possible connection with AsiaFlux were discussed. E. Phillip (Forest Research Institute, Malaysia) reported the research and development activities on climate change in Malaysia. She presented the C-sequestration capacity of several ecosystems (Peat swamp, Mangrove, Plantation, Inland forest, and others), based on the data of the C-sequestration inventory in Malaysian forest or the carbon budget study in Pasoh and Lambir Forest Reserves, and discussed the impact of climate change on these ecosystems based on the ecological data. C. Senthong (Chiang Mai University) introduced 6 flux sites in Thailand, which were constructed by members of the AsiaFlux, and their recent research works on micrometeorology. In addition, he introduced a new program entitled "The Royal Golden Jubilee Ph. D. program" granted by Thailand Research Fund to train young scientists of micrometeorology. M. A. Baten (Bangladesh Agricultural University) introduced the natural, agricultural, ecological, and scientific aspects of Bangladesh, and a plan to monitor the $CO_2$ and $H_2O$ fluxes at a rice ecosystem with help of National Institute for Agro-Environmental Sciences, Japan (NIAES). N. Hooda (Ministry of Environment and Forests, India) presented recent researches on the assessment of major carbon pools and fluxes in India's forest and their change caused by the change in the land use, based on the data sets of forest and soil carbon inventories of all over India and land use change data obtained by satellite

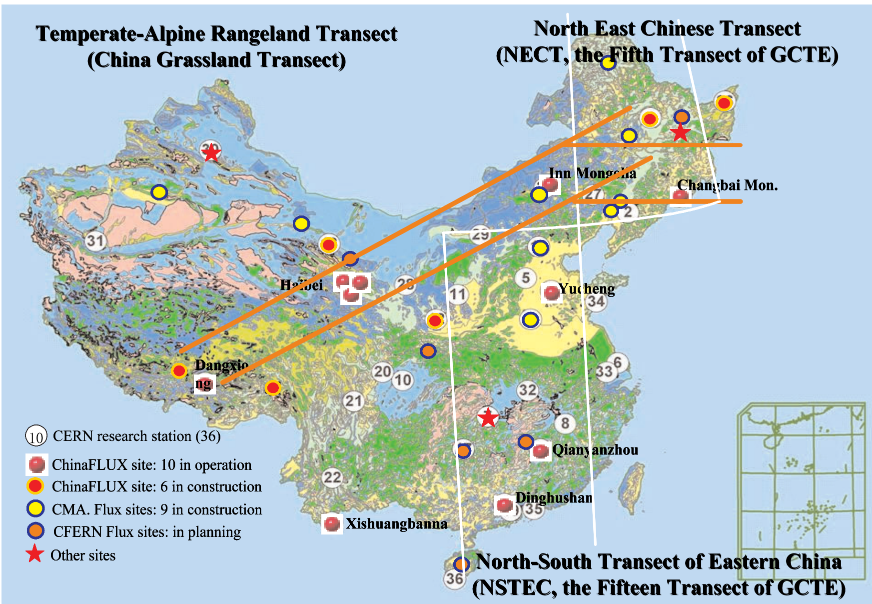


**Fig. 2 Map of ChinaFLUX network**

mapping. Additionally, she showed a prediction of the change in the NPP due to the climate change, using the BIOME-3 model. In order to improve its precision, she pointed out the necessity of the intensive research on the carbon dynamics by tower flux measurement at some of the typical forest ecosystems in India.

**2. Special Session "Complex Topography"**

There are many problems in the flux measurement on complex terrain. This session was held to recognize the problems and find solutions for them. Topics presented here were focused on nocturnal processes of $CO_2$ flux that is not well understood. L. Mahrt (Oregon State University) reviewed difficulties with eddy-correlation measurements in complex terrain, showing examples from field experiments in the central Oregon, USA. He stressed that the contribution of the advection with drainage flows to NEE is important. The horizontal transport can be estimated directly only with a dense measurement network, and the vertical motion is predictable by the divergence method based on the mass continuity equation. He also proposed a technique that varies in averaging length of flux calculation according to the stability and the measurement height (Vickers and Mahrt, 2003). This technique can provide superior fluxes without substantial contributions of mesoscale motions, which lead to a large unnecessary scatter when we estimate fluxes under the condition with weak turbulence. H. Kondo (National Institute of Advanced Industrial Science and Technology, Japan) reported the long-term $CO_2$ flux measurement at Takayama site in Japan. In this site, NEP estimated from the eddy covariance method was lager than that from biometric methods. This might be caused by the difficulties in $CO_2$ flux measurements at night. As a result of the examining details of the micrometeorology, irregular features on the time series of the $CO_2$ concentration and flux were found. He suggested that these features arose from the differences of fetch and wind direction and the influence of the advection. X. Wen (CAS) reported about the estimation of ecosystem respiration over a hilly region. He showed that the quality of eddy-flux data degrades as terrain complexity increases, and indicated the strategy of u* correction for nocturnal $CO_2$ fluxes in ChinaFLUX. To estimate ecosystem respiration range, he recommended combining different u* threshold values and ecosystem respiration models. In his report, the ratio of Gross primary production to Ecosystem respiration was used to evaluate the relative contribution of these exchange processes to the total annual exchange, and the ratio could be used for determining ecological rationality of ecosystem respiration. Y. Kominami (FFPRI) tried to estimate NEE of a deciduous forest in a complex terrain with various methods: eddy-covariance, chamber and biometric methods. Compared with the biometric and chamber measurements, u* threshold for nighttime respiration was determined. He also pointed out that the interpolation function varied with seasons and the seasonal change was occurred by the change in the growth respiration rate in spring and the decrease in soil respiration in summer. S. Okubo (Kyoto University) validated nighttime $CO_2$ flux data in a mountainous site by comparing with chamber measurements of leaf, trunk and soil respirations. He verified that nighttime NEE estimated from the tower-based measurement was nearly equaled to the ecosystem respiration estimated from the chamber measurements at high u* conditions. These results revealed a positive prospect of the u* correction in a complex terrain. M. Y. Leclerc (The University of Georgia) addressed the problems of nighttime flux measurements and their interpretation. She showed the impact of nighttime atmospheric phenomena (waves, low-level jet and so on.) on fluxes. The interactions between these phenomena at night suggested that tower flux measurements include not only the influence of the underlying surface, but also the influence of the structure of the atmosphere above. She cautioned about the selection of nighttime calculations of NEE: Not all periods exhibiting turbulent mixing with arbitrary above-threshold velocities qualify to represent surface-atmosphere exchange of a target area.

The following two studies are presented in other session but are strongly related to this issue,. R. Leuning

(CSIRO, Australia) introduced novel mass-balance approach to measure the mass balance of a 50×50×6 m control volume installed in a tall *Eucalyptus* forest in south east Australia. Net fluxes of $CO_2$ from the soil and vegetation were estimated from the vector sums of fluxes through the sidewalls and upper surface of the control volume. The novelty of the measurement system was the use of windspeed-weighted sampling of air from six air tubes per sidewall combined with eddy flux instrumentation at 6 m. The results showed that all terms in mass balance equation (change in storage, eddy flux across lid, and horizontal advection) were the same scale and important at night. In addition, 10-day mean mass balance flux agreed with the biological measurements, however the dynamics was different. Y. Kosugi (Kyoto University) validated evapotranspiration rate obtained by eddy flux observation at a hilly watershed using the watershed water balance evaluation. She suggested that the correction to close the energy budget improved the water budget in the watershed

**3. Other sessions (Long-term Flux Observation, Earth Observation and AsiaFlux, Biochemical Cycles in Terrestrial Ecosystem, Modeling and Remote Sensing of Terrestrial Ecosystem, and Poster session)**

In "Long-term Flux Observation" session, continuous flux observation studies in several ecosystem types in Asia (e.g. peat swamp forests, boreal forests, Japanese cypress forest, Tibetan plateau, croplands, Inner Mongolia steppe, coniferous plantation, and tidal zone) were introduced. In "Biochemical Cycles in Terrestrial Ecosystem" session, emission of carbons (e.g. $CO_2$, $CH_4$, and Isoprene) from each component (e.g. soil, stem, leaf, root) in several ecosystems were discussed. Some researchers had developed automatic chamber systems to evaluate the flux continuously. Additionally, many studies used stable isotopes to evaluate the water stress of forest trees, to partition NEE into photosynthesis and respiration factors, or to detect the origin of the respired $CO_2$. In addition, some studies discussed how land use change caused the change in the carbon dynamics, based on forest and soil carbon inventories. In "Modeling and Remote Sensing of Terrestrial Ecosystem" session, both localized process simulations and globalization using MODIS, TsuBiMo, and Sim-Cycle were discussed. Some researches used a neural network for the gap-filling of $CO_2$ flux data sets. As issues and problems of this session, the followings are proposed and discussed. 1. Validation of global ecosystem models, 2. How to incorporate small-scale processes into global models (scaling problem), 3. There are too many empirical equations (processes) that cannot be globalized (Respiration is a very important component - Q10 parameterization is grossly inadequate), 4. First principle approach? - Unification of concepts ("GCMs" of ecosystem models). In "Earth Observation and AsiaFlux" session, G. Inoue (NIES) presented possible contribution of AsiaFlux to an international operational observation "Integrated Global Carbon Observation (IGCO)" in Integrated Global Observing Strategy (IGOS; http://www.eohandbook.com/igosp/) proposed by WMO and UNEP, and the relation of IGCO to the research planning "Global Carbon Project (GCP; http://www.globalcarbonproject.org)" (Global Carbon Project, 2003) and the assessment "Intergovernmental Panel on Climate Change (IPCC)". In addition, he introduced the Greenhouse gasses observing satellite (GOSAT) that will be launched in 2008. GOSAT is developed by the Ministry of Environmen (Japan) and Japan Aerospace Exploration Agency and can estimate column-integrated atmospheric $CO_2$ and $CH_4$. H. Sawada (FFPRI) introduced the application of satellite data to monitor forest ecosystems. More than 50 studies, concerning the above-mentioned issues, were presented in the Poster session.

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# Development of Measurement System to Evaluate Forest Ecosystems:

## Measurement of Biomass Growth by Airborne Laser Survey

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**Introduction**

Under Kyoto Protocol to the UNFCCC (U.N. Framework Convention on Climate Change), Japan is committed to a reduction of carbon dioxide emission by 6% within the first commitment period compared to the base year, and 3.9% of which is expected to be achieved through "forest sink" activities. Although, afforestation is very difficult in Japan, the activities to increase $CO_2$ absorption are indispensable for the compliance of the obligation under the Kyoto Protocol in the "managed forest". Furthermore, the development of the techniques of evaluating the $CO_2$ absorption increase through these forest management activities is required. One of the techniques is a method of using airborne laser scanner that can survey not only the top of the tree canopy, but also the ground surface, and it can survey tree height for a wide area. Recently, important progresses on the forest measurement studies using laser scanner have been made, but the study on the forest growth detection using the laser survey has not been conducted yet. Therefore, we undertake a study to develop a method that can evaluate the forest growth.

**Materials and Methods**

Site description

The study site is a Japanese larch (*Larix kaempferi*) plantation in Tomakomai National Forest managed by the Hokkaido Regional Office of the Forestry Agency (Fig. 1). The larch forest located at 42° 44'N, 141° 31'E in Hokkaido, northern Japan, was planted in 1958. The site is on a flat terrain and the elevation is about 140 m above sea level. In the larch forest, some deciduous broad-leaf trees, such as birch (*Betula ermanii* and *Betula platyphylla* var. japonica) and Japanese elm (Ulmus davidiana var. japonica), invade into the gaps, and spruce trees (*Picea jezoensis*) grow sparsely (Hirano *et. al.*, 2003).

**Fig. 1 Tomakomai flux research site**

Field survey

The experiment plot (1ha, 100m × 100m) was set up in 1999, and the DBH (stem diameter at breast height; 1.3m above the ground) was surveyed for the trees of which DBH size was more than 5cm in December 1999, November 2001 and April 2004. Since the survey in 2004 was conducted before the growing period, the results in 2004 were regarded as the data in 2003. The measurement unit of DBH was 2cm in 1999, and was 1mm in 2001 and 2003. The tree height-diameter curve was obtained by the tree height survey in 1999 as,

$$H = -4.481 + 6.117 \log D \qquad [1]$$

where $H$ is the tree height (m) and $D$ is the DBH (cm).

Laser Survey

The laser scanning data were acquired in 1999, 2001 and 2003 by an airborne or heliborne laser survey (Table 1).

**Table 1 Flight data**

| Flight Name | F1999 | F2001 | F2003 |
|---|---|---|---|
| Flight Data | 9~10 Sep 1999 | 26 Sep 2001 | 9 Sep 2003 |
| Carrier Aircraft | Airborne | Heliborne | Heliborne |
| Pulse Density | 1.20 $m^{-2}$ | 81.12 $m^{-2}$ | 6.56 $m^{-2}$ |

Airborne laser scanner is a system that measures the altitude of a wide area using the LIDAR (LIght Detect and Ranging) mounted in the airplane. The laser pulses radiated from the airplane hit a terrestrial object, and are reflected. The detector in the airplane receives the reflected light, and the distance from the airplane to the terrestrial object can be calculated by the time span from the radiation to the detection. As the position and angle of the airplane are measured using GPS/IMU (Global Positioning System / Integrated Measurement Unit), the position of the hit point can be obtained from the distance. The laser pulses are radiated swinging from the right to the left, and the airplane cruises ahead, so the altitude data of the terrain in a wide area can be measured. In addition, airborne laser scanner can measure the tree crown heights. As the laser beams go straight, its diameter spreads. In the case of airborne laser scanner, the footprint size of the laser beam becomes about 30 cm on the surface of tree crown. Some laser beams, which reached a surface of a tree crown, are reflected, and the remainder passes through the foliages. The situation is like a sunshine filtering through foliage. At last, some laser beams can reach the terrain surface and we can measure the altitude of the ground surface (Fig. 2).

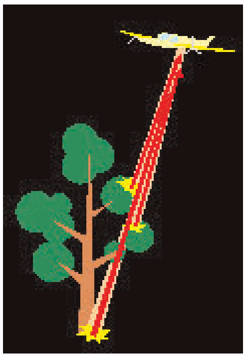

**Fig. 2 Laser beam**

Fig. 3 is the 3D-view of point crowds obtained by the laser survey in the study site. The green points show the first returned pulses of the laser, and the yellow points show another returned pulses. By filtering processing, the points are divided into the tree crown data and the ground data. And by interpolating processing, the canopy DSM (Digital Surface Model) and the DTM (Digital Terrain Model) were constructed from the points (Fig. 4).

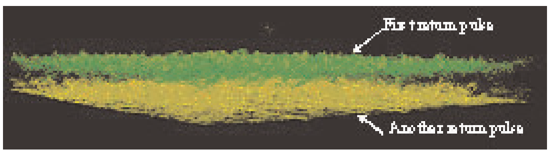

**Fig. 3 The 3D-view of point crowds**

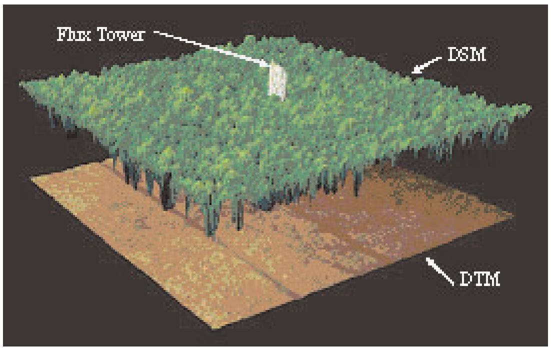


**Fig. 4 The 3D-view of DSM, DTM and the flux research tower.**

The tree crowns were extracted from the canopy DSM by the Watershed method (Fig. 5).

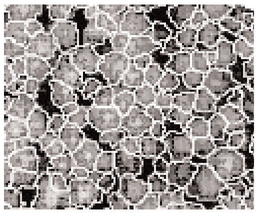

**Fig. 5 The detected tree crown polygons**

The Watershed method is processed by the following procedure. First, the DSM is reversed. Next, the reversed DSM is considered to be a terrain surface and the waterways which flow into the top of trees from the tree crown edge are calculated. Finally, the line of the ridge, which is the connection of the starting point of the waterway, is recognized as a tree crown polygon.

The tree heights are measured as the difference between the highest point of the laser within the tree crown polygon and the DTM (Fig. 6).

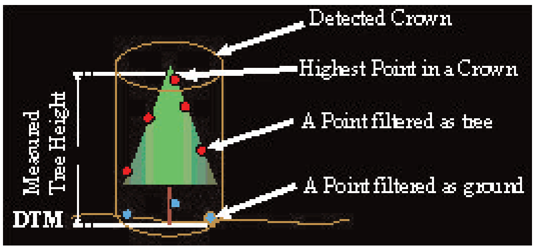


**Fig. 6 Measurement of the tree height**

The tree height measured by the laser survey tends to be underestimated. Height underestimation is caused by the penetration of the laser through the foliage and by the discrepancy between the treetop and the highest hitting point in the crown. Therefore, tree heights were corrected as

$$Hc = A + B \times H \qquad [2]$$

where $Hc$ is the corrected tree height (m), $H$ is the tree height (m), $A$ and $B$ are parameters. $A$ and $B$ are estimated from the data of F2001. Since the pulse density of F2001 was very high, it was assumed that the laser hits the top of the tree and the tree height obtained by the laser data was correct. Then the pulse density of F2001 was thinned out to $1.20m^{-1}$ and $6.56m^{-1}$ as the same density in F1999 and F2003, respectively. And the parameter was calculated based on the difference of the height obtained from the original data of F2001 and the data after thinning out.

In the survey from an airplane, the measurement of understorey tree height is difficult. So, the understorey tree height was predicted using the method adopted by (Osawa *et. al.*,2001). They estimated the total stem volume of an even-aged pure stand by MNY method (Hozumi *et. al.* 1968) using the height data of only the largest trees in the stand.
(For details, please refer to Yone *et. al.*, 2005.)

Stem Volume and NPP

On the field survey, the tree heights were calculated from their DBH, and on the laser survey, the tree DBHs were calculated from their height using equation [1]. The stem volumes are calculated by using stem volume formula obtained in Hokkaido (Nakajima, 1948).

Net Primary Production (NPP; gC $m^{-2}$) of the forest stand is calculated as

$$NPP = \triangle W + L + G \qquad [3]$$

where $\triangle W$ is the increment of the oven-dried stem ,branch and root weights except the leaves (gC $m^{-2}$), $L$ is the mortality (gC $m^{-2}$) and $G$ is the quantity of prey (gC $m^{-2}$). The oven-dried weights of stems and branches ($w$), and the oven-dried weights of leaves ($w_l$) are calculated from the stem volume ($V$) using the following equation (Yone *et al.* 2002), which was obtained from trees near this site.

$$w = 4.0302 \times 10^{-1}\, V \qquad [4]$$

$$w_l = 1.0540 \times 10^{-2}\, V \qquad [5]$$

The oven-dried weight of all parts of a tree is calculated from the ratio of each tree part as

$$w_{rs} : w_{rb} : w_{rl} : w_{rr} = 60:8:12:20 \qquad [6]$$

$$w_{el} = w \times (w_{rs} + w_{rb} + w_{rr}) / (w_{rs} + w_{rb})$$
$$= w \times (60 + 8 + 20) / (60 + 8) \qquad [7]$$

where $w_{rs}$, $w_{rb}$, $w_{rl}$ and $w_{rr}$ is the oven-dried weight of stems, branches, leaves and roots, respectively, for coniferous trees in Japan (Matsumoto *et al.*, 2000), and $w_{el}$ is the oven-dried weight of all parts except leaves. The carbon weight is calculated by multiplying the oven-dried weight by the carbon content: 0.5.

**Results and Discussion**

The average tree heights obtained from the laser survey are shown in Fig. 7. This average height was for upper storey trees. The annual growth in height is 0.23~0.25cm・$y^{-1}$. The height growth investigated by the stem analysis in the adjacent larch forest is about 0.25cm・$y^{-1}$, therefore, the laser survey has an ability to detect the yearly change in the tree heights.

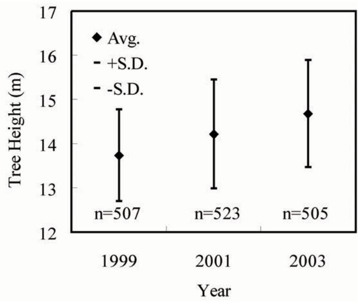


**Fig.7 Average tree height obtained by laser survey.**

The tree height histograms obtained from the complete enumeration, laser survey, and prediction from the laser survey using the MNY method are shown in Fig. 8, and the estimated total stem volumes are shown in Fig. 9 (For details, please refer to Yone *et. al.,* 2005). The tree height obtained from the laser survey is only the upper storey trees and the total stem volumes were underestimated. However, by using the MNY method, the shape of the histogram and the total stem volume become close to those of the complete enumeration data.

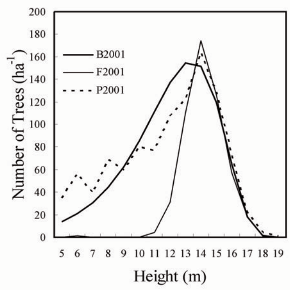


**Fig. 8 Histogram of tree heights (example in 2001). Dotted lines (P), thin lines (F) and thick lines (B) are the result of the complete enumeration, laser survey, and prediction from laser survey using the MNY method.**

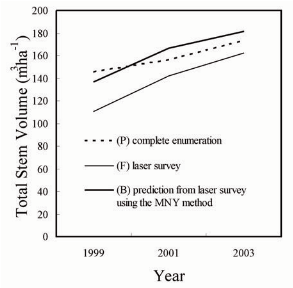


**Fig. 9 Estimated total stem volumes. Dotted lines (P), thin lines (F) and thick lines (B) are same as in Fig. 6.**

The estimated NPP using the field survey and laser survey data are 396 gC m$^{-2}$ yr$^{-1}$ and 352 gC m$^{-2}$ yr$^{-1}$, respectively, for 2001 to 2003. These NPP values were in good agreement.

We conclude that, by using laser survey, (1) the forest stand growth can be detected, (2) the understorey tree heights can be predicted from the DSM combined with the MNY method, and (3) forest stand NPP can be estimated.

A future subject is a comparison between the estimated NPP and the value obtained by the micrometeorological method.

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# Flux Observation in a Tropical Peat Swamp Forest in Central Kalimantan, Indonesia

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Peatlands are widely distributed in the tropics. The area of tropical peatlands is estimated to be 420,000 km$^2$, and it accounts for 12% of global peatlands. Kalimantan, Indonesian territory of Borneo Island, contains 70,000 km$^2$ of peatlands on its lowlands. Tropical peatlands accumulate a large amount of carbon as organic matter, which is estimated as 70 Pg. Carbon stored in tropical peat soil accounts for about 2% of global soil carbon. Tropical peatlands naturally co-exist with forests. Recently, however, deforestation and drainage are in progress on a large scale because of a growing demand for timber and farmland. In addition, the ENSO drought and related fires are accelerating the forest devastation. Such devastation enhances the decomposition of organic matter stored in peatlands, and consequently increases carbon release to the atmosphere as $CO_2$. This suggests that tropical peatlands will be a major $CO_2$ source in the near future. Therefore, to evaluate the $CO_2$ balance of tropical peatlands, a group of researchers from Hokkaido University and University of Palangkaraya has been measuring $CO_2$ flux from a tropical peat swamp forest remaining in Area B of the Mega Rice Project near Palangkaraya, Central Kalimantan, Indonesia since November 2001 with the aid of JSPS Core University Program and the Grant-in-Aid for Scientific Research from MEXT Japan.

The forest is a secondary forest growing after selective logging conducted intermittently until the 1990's (Fig. 1), which is located on a flat peatland between a river and a channel. Water table in the forest was zonally reduced near the channel. A tower of 50 m height was constructed around the north edge of the forest (2° 20' 42" S, 114° 2' 11" E) (Fig. 2). Dominant tree species of the forest are *Combretocarpus rotundatus, Cratoxylum arborescens, Buchanania sessifolia* and *Tetrameristra glabra* and rich shrubs grow in the trunk space. The height of the forest canopy is about 26 m. Predominant wind direction is south (SE-SW). Fetch is longer than 3 km for the southern wind. In this area, the dry season begins in May and lasts until October, judging from monthly precipitation of 100 mm. During the dry season of 2002, between mid-August and late October, peatland fires occurred extensively in Kalimantan because of the ENSO drought, although the forest trees did not burn.

$CO_2$ and energy fluxes have been measured at 41.7 m by eddy covariance technique with a sonic anemometer-thermometer (CSAT3, CSI) and an open-path $CO_2$ analyzer (LI7500, Licor) facing south. Sensor signals are recorded with a data logger (8421, HIOKI) at 10 Hz. $CO_2$ concentrations have been also measured at six heights below the flux measurement height with a closed-path $CO_2$ analyzer (LI820, Licor) at a rotation interval of 1 min to calculate $CO_2$ storage flux. In addition, soil respiration has been measured continuously using an automated chamber system since 2004. On the tower, meteorological valuables which include downward and reflected short-wave radiations, long-wave radiations and photosynthetic photon fluxes (PPFD), air temperature, relative humidity and precipitation, have been measured and recorded every 30 min since July 2001, along with soil temperature, soil moisture and water table. All systems use solar energy for the power supply.

The following studies are in progress using the long-term flux and meteorological data: 1) evaluating the $CO_2$ and energy balances of the tropical peat swamp forest which was drained (Hirano *et al.,* 2005), 2) seasonal and interannual variations in the $CO_2$ and energy balances, 3) the effects of the ENSO drought and related peatland fires on the $CO_2$ and energy balances. In 2004, we established new towers at a deforested peatland and another peat swamp forest within several kilometers from each other and began flux observation. The former site was burnt in two ENSO years, 1997 and

**Fig. 1 View of the forest canopy**

**Fig. 2 View of the tower**

2002, and now vegetation is regrowing. The latter site is also a secondary forest but is undrained. Furthermore, the channels working as drainages were dammed up this year to keep the peat water content saturated, with supports from Finish and EU funding. Taking advantage of the flux network of three towers and the dam construction as a large-scale field manipulation experiment, we will better investigate the effects of disturbances on the $CO_2$ and energy balances of tropical peatlands.

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## AsiaFlux Training Course on Micrometeorology will be opened in the summer of 2006

In order to provide a fundamental and comprehensive knowledge of current micrometeorological theory and flux measurement to principal flux investigators in Asia, "AsiaFlux Training Course on Micrometeorology" will be opened in the summer of 2006.

Subjects will include atmospheric boundary layer, canopy micrometeorology, data processing and quality control, and equipments handling.

All lectures and class materials will be given in English. Several investigators will be invited, and their traveling expenses and accommodation fee will be covered by AsiaFlux. The details will be notified through AsiaFlux website (http://www.asiaflux.net) by early November 2005. So please check the website.

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AsiaFlux workshop 2005 was held successfully and advanced AsiaFlux activities are now constructed.

The editor of AsiaFlux Newsletter No.15:
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