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Contents

12th AsiaFlux Workshop 2014
-Bridging Atmospheric Flux Monitoring to National and International Climate Change Initiatives-

Ma. Carmelita Alberto

Workshop Local Organizing Committee
International Rice Research Institute, Los Baños, Laguna, Philippines

The 12th AsiaFlux Worskop was held on 18 -23August 2014 at the International Rice Research Institute (IRRI) in Los Baños, Laguna, Philippines (Fig. 1). This is the third AsiaFlux workshop held in Southeast Asia: the first workshop was organized in Cheng Mai, Thailand in 2006 and the second workshop in Johor Bahru, Malaysia in 2011. The theme of the 2014 workshop 'Bridging Atmospheric Flux Monitoring to National and International Climate Change Initiatives' is part of the continuous endeavor towards the fulfillment of AsiaFlux mission which is to bring Asia's key ecosystems under observation to develop and transfer scientific knowledge in order to ensure the quality and sustainability of life in Asia. The terms such as 'monitoring' and 'under observation' go beyond just measurements and include synthesizing the observations to potential narratives and providing feedbacks, which serve as the source of the community learning toward sustainability.

Fig. 1. 12th AsiaFlux workshop participants

According to Dr. Akira Miyata (Chair of AsiaFlux), AsiaFlux has three significant reasons to hold its regular workshop at IRRI. Firstly, it is located in tropical Asia, which attracts increasing attention of our community. AsiaFlux has been focusing on tropical ecosystems in monsoon Asia since the workshop in Johor Bahru, Malaysia in 2011. The AsiaFlux Workshop 2014 in the Philippines will help us to intensify our activities in South and Southeast Asian countries. Secondly, IRRI is one of the focal points for research of crop science in the world. We expect the workshop here to provide us with the best opportunity to discuss how to promote flux studies in Asian agricultural ecosystems, which to date has drawn less attention in our community than forest ecosystems. Finally, IRRI has a long history of methane flux studies. Owing to recent improvement of gas analyzers, the technique for continuous measurements of methane flux has come to fruition. The number of eddy-covariance flux tower sites with methane eddy flux measurements has been increasing worldwide. It is timely for us to have the workshop here to discuss our progress in methane flux studies with attendance of scientists well-versed in methane studies in rice fields.

For this purpose, the AsiaFlux Workshop 2014 provided a platform for scientists and the like who are interested in ecosystem science in Southeast Asia to congregate, share information, and discuss future collaborations to consolidate and strengthen the Southeast Asian flux site networks.

The workshop started with a 2-days training course (18-19 August) on monitoring net ecosystem-scale fluxes using eddy covariance and profile measurements. The actual workshop, which took place on 20-22 August, comprised of six oral sessions, one poster session, and a special session which highlighted ongoing experiments conducted by IRRI aiming at higher rice productivity alongside with reducing environmental footprints. This workshop also provided opportunities for young scientists to express their views and experiences related to flux observation in the Young Scientist meeting. More than 110 participants from 19 countries attended the workshop, where 44 oral and 31 poster presentations were presented.

Short training course

The training course encompassed recent advances in micrometeorological instrumentation and the use of Campbell Scientific systems in ecosystem-scale flux monitoring. The course had particular emphasis on sonic anemometry, open-path and closed-path eddy covariance systems, and atmospheric profile systems. Basic theories and assumptions were discussed with respect to proper use and installation of instrumentation. The training course was attended by more than 30 participants (Fig. 2). The training was given by competent Campbell Scientific Applications Engineers and Scientists (Sasha Ivans, David Hammond, Gavin Hewitt, and Thitipong Chindavijak).

Fig. 2. Training Course participants

Opening Session

The 12th AsiaFlux Workshop was officially opened on 20 August 2014 with the inspiring welcome messages from Dr. Robert Zeigler, Director General of IRRI; Dr. Akira Miyata, Chair of AsiaFlux; and Dr. Reiner Wassmann, Chair of AsiaFlux Workshop Local Organizing Committee, IRRI (Fig. 3). The opening session was highlighted by a video presentation specially prepared by Ms. Berns Joven.

Oral Sessions and Invited Speakers

There were six oral sessions and one special session presented: (1) Special session - Linking mitigation efforts to natural resource management: IRRI's activities on determining GHG fluxes from rice-based ecosystems (convened by Reiner Wassmann and Maricar Alberto); (2) Session A – Carbon and water cycles in tropical and subtropical Asian ecosystems in changing environment (convened by Nobuko Saigusa, Amnat Chidthaisong, and Takashi Hirano); (3) Session B – Impacts of extreme climate and disturbances on carbon, water and material cycles in terrestrial ecosystems under monsoon climate (convened by Ryuichi Hirata and Kentaro Takagi); (4) Session C – Linking flux monitoring to climate change initiatives in agro-ecosystem (convened by Akira Miyata, Wonsik Kim, and Keisuke Ono); (5) Session D – Model-data integrative analysis towards better understanding of terrestrial carbon budget in Asia (convened by Masayuki Kondo and Kazuhito Ichii); (6) session E – Soil-plant-atmosphere interactions: mechanisms, responses, and approaches for understanding the Asian terrestrial carbon cycle (convened by Naishen Liang and Jin-Sheng He); and (7) Session F – Up-to-date techniques and understanding for trace gas and methane fluxes (convened by Yoshiyuki Takahashi and Masahito Ueyama). (Fig. 4)

Five invited speakers graced the AsiaFlux workshop 2014 by sharing their expertise and current studies: (1) Dr. Dennis Baldocchi (Role of weather, land use and management on greenhouse gas fluxes in Sacramento Delta); (2) Tomo'omi Kumagai (Carbon and water cycling researches in southeast Asian tropical forests); (3) Tamotsu

Fig. 3. Opening Session

Fig. 4. Oral Sessions

Sato (EA-FDPN: Plots network for forest and carbon dynamics from Siberia to tropical zone); (4) Xuhui Lee (Land use changes, energy fluxes and surface climate); and (5) Jin-Sheng He (Carbon and methane fluxes from alpine grassland and wetland on the Tibetan plateau: effect of climate warming and water table decreasing).

Poster Sessions

There were two poster sessions held on 20 August (1545-1630H) and on 21August (1115-1200H).
The poster sessions provided ample time for in-depth interactions between the authors and the rest of the workshop participants (Fig. 5). The AsiaFlux Workshop Scientific Steering Committee also evaluated all the poster presentations of the young scientists for the 'Best Poster Paper' award.

Fig. 5. Poster Sessions

Young Scientist Meeting

The Young Scientist Meeting (YSM) is an important part of the AsiaFlux Workshop. YSM has been kicked off in January 2008 under the framework of AsiaFlux. This year's YSM was organized by Keisuke Ono, Caesar Arloo Centeno, Minseok Kang, and Motonori Okumura. The meeting aims to provide opportunity for: (1) discussions with outstanding senior and young scientists from in and outside Asia on a range of topics including science and career paths; (2) sharing experiences with the speakers and among the young

Fig. 6. Young Scientist meeting

scientists on particular fields of research; (3) the young scientists to relate their career paths with the success stories of the speakers; and (4) future collaborations between young scientists and the speakers (Fig. 6). About 40 young scientists from China, Korea, Malaysia, Indonesia, Hong Kong, Singapore, Japan, and the Philippines participated in this meeting.

Business Display

The organizing committee of AsiaFlux Workshop 2014 would like to thank all the companies that have given great support through their participation in the business display throughout the workshop. The participating companies are EKO Instruments Co., Ltd., Campbell Scientific, Kipp & Zonen Asia Pacific Pte., Ltd., and LICOR, Inc. (Fig. 7).

Fig. 7. Business Display

Fig. 8. Best Poster award winners

Fig.9. 'Early Bird' award winners

Fig. 10. Tokens of appreciation to the 5 invited speakers and 4 Campbell Scientific trainers

Awards and Closing Ceremony

Two young scientists garnered the 'Best Poster Paper' award, namely, Ayaka Sakabe and Kojiro Hirayama (Fig. 8). The local organizing committee initiated the 'Early Bird' awards for those who have paid the registration fees first: (1) international participant - Montri Sanwangsri; (2) local participant - Caesar Arloo Centeno; and (3) Business Display – LICOR, Inc. (Fig. 9).Tokens of appreciation were likewise given to the 5 invited speakers and to the 4 Campbell Scientific trainers (Fig. 10).

The closing remark was given by Dr. David Johnson, Head of Crop & Environmental Sciences Division, IRRI.

Banquet and Farewell Dinner

All the participants were warmly welcome during the banquet which was held at the IRRI GuestHouse on 20 August 2014 (Fig. 11). There were cultural performances by the University of the Philippines at Los Baños (UPLB) Dance Troupe. They showcased some of the dances in the different parts of the Philippines. The UPLB Dance Troupe was also successful in encouraging the AsiaFlux participants to join them as they dance the famous 'Tinikling', i.e., dancing along bamboo poles.

The Farewell Dinner was held in Bonito's Bar and Restaurant along UPLB Grove on 22 August 2014 (Fig. 12). The participants had a good chance to enjoy different Filipino dishes, appetizers, desserts, and drinks.

Fig. 11. A taste of Filipino food, culture and hospitality (left) Fig. 12. Farewell Dinner (right)

IRRI Tour

The AsiaFlux participants had a glimpsed of the IRRI Rice World Museum. The museum exhibits artifacts concerning the rice-growing world and shows the important role of rice through Multi-media and photo exhibits. The display area contains a large collection of rice artifacts, farming tools, farm machineries, rice products and by-products, illustrations of rice ecosystems, samples of rice seeds from different parts of the world, replicas of rice granaries, farmers' clothing, insects that are friendly and harmful to rice, photographs of women rice farmers, and representations of rice biotechnology. There are also sections in the museum, which have computer terminals and 'hands-on' models to enhance the learning experience (Fig. 13).

Fig. 13. IRRI Rice World Museum

The IRRI Field tour (22 August 2014) consisted of visits to 2 experimental sites: (1) the Ecological Intensification Platform and (2) the ICON fields (Introducing Non-Flooded Crops in Rice-Dominated Landscapes: Impact on Carbon, Nitrogen and Water Cycles). These 2 study sites provide opportunities for developing and researching probable futuristic rice production systems that are environmentally and economically sustainable. These studies contribute to process-based research on element cycles and GHG emissions, e.g. by using Eddy Covariance techniques and chamber-based measurements (Fig. 14)

Fig. 14. IRRI Field Tour

Fig. 15. Excursion Option A: Tagaytay Tour

Excursion

The local organizing committee had organized two excursions after the workshop (23 August 2014):

Option A (Tagaytay Tour)

This tour started with Ilog Maria Bee Farm, which is the largest producer of honey and other bee products in the country. Then the participants had a sumptuous lunch at Sonya's Garden, which offers romantic nature garden dining. The day ended in Tagaytay Picnic Grove which showed a good vantage view of Taal Volcano Island in the middle of a lake (Fig. 15).

Option B (Laguna Tour)

This tour started with Costales Nature Farm, which is a prime agro-tourism destination that conducts ecological and balanced farming techniques in order to promote sustainable agriculture, healthy lifestyle, and environmental diversity through integrated natural farming. The tour ended in Makiling Botanic Gardens, which was designated as a tourist destination and as a recreational and educational facility for the general public since 1965 (Fig. 16).

Fig. 16. Excursion Option B: Laguna Tour

Report on the AsiaFlux Training & seminar on tropical ecosystem monitoring 1-5 December 2014, National Park Cat Tien, Vietnam

Avilov Vitaly[1,3], Dinh Ba Duy[1,2], Juliya Kurbatova [1,3]

[1]Vietnamese-Russian Tropical Center, Southern Branch, Ho Chi Minh City, Vietnam
[2]Institute of Tropical Ecology/Head Office, Vietnamese-Russian Tropical Center, Hanoi,
[3]A.N. Severtsov Institute of Ecology and Evolution RAS, Moscow, Russia

Tropical ecosystems are the most diverse ecosystems with high magnitude of carbon and water turnover. Incidentally, these ecosystems are the most disturbed in modern times. Now we see an increasing interest in study of functional processes in tropical ecosystems and their role in biosphere-atmosphere exchange of water and trace gases. AsiaFlux has been collaborating and supporting those studies in Southeast and South Asian countries. As part of those activities, AsiaFlux provided a training and seminar on tropical ecosystem monitoring, which was held in headquarters of Cat Tien National Park, a part of Dong Nai Biosphere Reserve, Vietnam. Nearly 50 participants from 23 institutions of 9 countries attended the seminar. Hands-on training courses on ecosystem monitoring and data processing were the main activities. (Fig.1)

The course provided by LI-COR Inc., was carried out on 1-3 December 2014. It covered a range of topics on measurements in ecosystems, with focus on quantification of greenhouse gases and energy fluxes by means of eddy covariance technique. Training was started from the basics and theory of the eddy covariance, with explanation of possible sources of errors and uncertainties in measurement results. A possible application of the method in scientific and industrial purposes was discussed. Instrumental part of the training was to explain the principles of operation and interaction of NDIR and WMS gas analyzers, such as LI-COR LI7500A and LI7700, sonic anemometers and other biometeorological sensors and auxiliary equipment. New advantages of on-site data integration and processing using the SmartFlux system were shown. A demonstration eddy covariance and biometeorological measurement complex was assembled and adjusted by participants for a given site specification. Data process-

Fig. 1. Training course and seminar participants

ing part of the training gave participants the skills of raw eddy covariance data processing using EddyPro software and interpretation of outputs for data quality assessment and analysis. The last part of training focused on soil respiration and LAI measurements. The LI-8100A Automated Soil CO_2 Flux System was presented with use of survey or long-term automated chambers. Main physical principles and common mistakes of soil respiration measurement were discussed. LAI-2200C Plant Canopy Analyzer was presented as an instrument for leaf area index measurements, with explanation of specifications and principles of operation and LAI calculation and practical recommendations for taking measurements.

Many of the participants for the first time were acquainted with the methods of ecosystem flux measurements, and more experienced participants had the opportunity to deepen their knowledge in these areas and discuss directly with representatives of the equipment manufacturer. (Fig.2)

Fig. 2. During training course and seminar

Seminar on tropical ecosystem monitoring

The seminar was opened by welcome addresses from Chair of AsiaFlux Dr. Akira Miyata. Two keynote speakers were then followed. The first one was delivered by Dr. Yoshiaki Kitaya from the Graduate School of Life and Environmental Sciences, Osaka Prefecture University, Japan. He updated the current situation of mangrove forest and emphasized the importance of improving our knowledge and understanding for this forest ecosystem. Dr. Alex Guenther (Pacific Northwest National Laboratory, Richland WA, USA) presented the lecture on "Ecosystem–atmosphere exchange of biogenic volatile organic compounds". The main subjects of lecture included current understanding of the processes linking air quality, climate and biogenic organics and their potential feedbacks. The need for long-term, canopy-scale monitoring of Biogenic Volatile Organic Compounds (BVOCs) was discussed and measurement techniques were described. After the keynote speeches, each presenter shared his/her recent research interests, and joined by discussions from the audiences.

This was followed by presentations from participants. A presentation by Dr. Juliya Kurbatova and Vitaly Avilov showed the results of studies of heat, water and carbon fluxes measurements in monsoon tropical forest of Cat Tien National Park. Robert Sandlerskiy presented his findings on the feasibility of tropical forest classification by means of multispectral satellite data analysis.

The lectures by scientists from India introduced a wide range of flux studies conducted in their country. Rakesh presented the studies of carbon fluxes and biomass density over central Indian deciduous forests; Dr. Singh presented his findings on carbon, water and energy dynamics in Himalayan forests ecosystem; Dr. Banerjee shared about latent energy flux over rice field. He pointed out that efficient use of irrigation water requires proper estimation of evapotranspiration.

Dr. Kasturi Devi Kannian introduced his studies of fluxes in urban ecosystem in Malaysia. Joseph Waili reported about eddy covariance measurements of evapotranspiration from a tropical peat swamp forest in Sarawak (Malaysia); Cheng Yu Lan shared studies of surface fluxes of a subtropical broadleaf forest at the Lien-Hua-Chin experimental watershed in central Taiwan; Dr. Tassanee Jiaphasuanan from Thailand shared her study results on methane and nitrous oxide emission from irrigated rice field with different cultivation practices.

Dr. Koji Tamai from Japan reported on the roles of tower observation in the development of CO_2/H_2O cycle simulation model for forest ecosystem; Hironori Arai presented his findings on methane emission and soil microbiological properties in mangrove forest soils; Dr. Kazuyuki Inubushi from Chiba University reported about effect of topography on N_2O and CO_2 emissions and dissolved N_2O in palm plantation in Indonesia.

For participants it was very useful and interesting to know about the development of flux measurements in Vietnam. Dr. Duong van Hau from Hue University of Agriculture and Forest presented the results of water management on growth, development, yield of rice and greenhouse gas emissions in Central Vietnam. Joint presentation of Truong van Vinh (Non Lam University) and Nguyen Thanh Nho (University of Science, Vietnam) introduced the ability of mangroves to fix atmospheric greenhouse gases in Mekong river.

The seminar was finished by joint discussion about tropical ecosystem monitoring.

Field excursion (Fig.3)

The field excursion to Nam Cat Tien Forest (NCT) flux monitoring site was held on 5 of December. The flux monitoring site was established in late 2011, but many scientific researches were conducted in the Nam Cat Tien since 1990-s (Vandekerkhove & Chinh 1993; Blanc et al. 2000; Tiunov 2011).

The site is placed in seasonally-dry tropical forest dominated mainly with *Lagestroemia caluculata, Afzelia xylocarpa, Sindora siamensis*, canopy height is about 35 meters. Mean annual temperature recorded at nearest long-term weather station (Đồng Xoài) is 26.4°C and mean annual precipitation is 2518 mm.

Eddy covariance instruments installed on the top of 50-m height stout tower of 2x2m cross-section, along with solar radiation and other weather sensors. There is 8-level profile system for CO_2 and sensible heat below-canopy storage assessment, which is very important for tropical forests. The site also equipped with extended soil temperature and water content monitoring system, which consists of 3 sets of sensors on 4 depths from 5 to 50 cm. All instruments are operated autonomously using solar panels as a source of energy.

Soil respiration and tree litter deposition are measured on 100-m transect with 20 sampling points. Also short-term soil respiration was measured with custom made automatic chamber, aiming to estimate diurnal variations of soil respiration and its dependence on soil temperature.

Nam Cat Tien site, established by Russian-Vietnamese Tropical Research Center (VRTC), is the first permanent long-term flux monitoring site in Vietnam, has been in operation for 3 years and is open for collaboration for widening of research in area of tropical forest ecosystems.

This seminar was the first introduction to Vietnam with AsiaFlux community, and we look forward to establish closer collaborations
with Vietnamese authorities and other countries.

Acknowledgements

We would like to give our utmost gratitude to the members of local organizing committee for their support: Dr. Nobuko Saigusa (National Institute for Environmental Studies (NIES), Japan), Nguyen Van Dien (Cat Tien National Park, Vietnam) and Dr. Nguyen Dang Hoi (Institute for Tropical Ecology, VRTC, Vietnam).

Also, many thanks go to the head of the project, Dr. Akira Miyata (National Institute for Agro-Environmental Sciences (NIAES), Japan) who has created a great opportunity for exchange and sharing of scientific. We specially thank the AsiaFlux secretary, MSc. Sawako Tanaka (NIES, Japan), who supported and encouraged us about articles, plans and giving other useful information.
We express warm thanks to Dr. George Burba and Dr. Israel Begashaw (Li-Cor Inc.) who gave the permission to use all required equipment and the necessary materials to complete the training course as well as their technical support and guidance. Furthermore we sincerely appreciate those who submitted their articles even though they have been busy for their own research and work. Last but not least, a special thanks goes to our team: Dao Thu Huong, Manh Vus, Do Phong Luu, and other staff of VRTC and Cat Tien National Park who help us to assemble the parts and gave suggestion about the Seminar and Training course.

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Fig. 3. Field excursion

Reflections from Thai Young Researchers on Participating in the AsiaFlux Training Courses

1. Monitoring net ecosystem-scale fluxes with eddy covariance and profile measurements on 18-23 August 2014 at International Rice Research Institute (IRRI), Los Baños, Philippines

Watcharapong Boonruang[1], Pimsiri Suwannapat[1], Montri Sanwangsri[1], Jate Sathornkich[2]

[1]School of Energy and Environment, University of Phayao (UP), Phayao, Thailand, [2]Department of Horticulture, Faculty of Agriculture, Kasetsart University (KU), Bangkok, Thailand)

Watcharapong: I was selected from AsiaFlux Committees for attending the 2014 AsiaFlux Training Course. The objective of fellowship was to provide an opportunity for the young students and scientists in Asia who are interested in flux measurements. I was very excited and happy to be one of those selected. Together with me, several ThaiFlux members also joined this event and presented papers; 1) Energy fluxes in dry dipterocarp forest, Thailand 2) Introduction to new ThaiFlux site: Dry dipterocarp forest flux Phayao site (DPT) and 3) Carbon and water flux measurements of young rubber ecosystem in north-eastern region of Thailand. We have learnt about several major topics on flux measuremetns and have had opportunity for sharing ideas with professionals. Young Thai participants are excited to have new opportunity to expand our study in a Thai forest (DPT) and to include such measurements in the future under the ThaiFlux network and AsiaFlux network.

Fig. 1. At IRRI

Throughout the training course in day 1, we have learned about theoretical introduction to micrometeorology and flux measurements. This is very important aspects and considered the principle of turbulence and eddy covariance technique, storage, advection and instrumentation. In day 2 we have learned a lot about loggernet (CR1000) introduction, instrumentation such as open path eddy covariance system: IRGASON components and setup, closed path eddy covariance system: CPEC200 components and setup, water and CO_2 profiling system: AP200 components and setup including hand on presented by Campbell scientific. This made us realized the needs to understand this subject thoroughly for the correct flux measurement. This was the first time for some of us and was a good chance to learn from senior scientists, we will make more efforts and take more courses in order to improve our understanding about flux measurement and so on.

Fig. 2. Training course and poster presentation

During field excursion to IRRI experiment, all Thai participants visited the fields where the flux measurements by automatic close chamber and the new CH_4 flux measurement system (open path CH_4 analyzer) in upland and lowland paddy field were in operation. We also realized that this may be something we could have back in Thailand and we hope to contribute to its advancement in the future. In conclusion, participations in the training course and the conference events have provided young Thai participants with a lot of knowledge and involved them in the young scientists network, which is very important for our future works with fluxes community in Asia and in the world.

Finally, we would like to thank the AsiaFlux Committees for giving us this good opportunity to learn and improve our knowledge on the science of flux measurements, and special thank to Dr. Akira Miyata, Dr. Shenggong Li, Dr. Nobuko Saigusa ,Chair and Vice-Chairs of AsiaFlux and Dr. Reiner Wassmann, Dr. Ma Carmelita Alberto and Sawako Tanaka, the local organization to support everything. Without such supports, we would not be able to participate in this training and would miss such important experiences in our research life.

Fig. 3. IRRI Flux site

2. Tropical Forest Ecosystem Monitoring , 1-5 December 2014, National Park Cat Tien, Vietnam

Rungnapa Kaewthongrach

The Joint Graduate School of Energy and Environment, King’s Mongkut University of Technology Thonburi, Bangkok, Thailand.

This was my first time joining in AsiaFlux training and seminar. I was impressed especially when I had opportunity to learn directly with the renounced experts in eddy covariance, who I had never thought to meet them in person (such as George Burba and Israel Begashow). I have learned a lot on installing and maintaining the instruments and I will apply such knowledge to my own study. Moreover, I have got many nice friends with whom I had opportunity to share ideas. From such activities, I have got many valuable suggestions which relate to my research. This seminar also inspires me to create and improve my own experiments. For example, the modified float equipment for estimating the greenhouse gas at mangrove forests in Vietnam is quite interesting and inspiring. In addition, at Cat Tien National Park the measurements of CO_2 concentration at various levels from inside canopy to above canopy at the height of 59 meters, and the soil respiration measurement with automatic chamber and the manual methods are quite interesting and provide very good examples for setting up the experiment to answer complex scientific questions in tropical forest.

Fig. 4. At Cat Tien National Park

I would like to thank AsiaFlux and local organizers for arranging such excellent training (content and atmosphere).

Supersite in Boreal Forest of Alaska Established by a Japan and USA Collaboration Study

Rikie Suzuki[1], Hiroki Ikawa[2], Yongwon Kim[3], Konosuke Sugiura [4,1]

[1]Department of Environmental Geochemical Cycle Research, Japan Agency for Marine-Earth Science and Technology
[2]Agro-Meteorology Division, National Institute for Agro-Environmental Sciences
[3]International Arctic Research Center, University of Alaska Fairbanks
[4]Center for Far Eastern Studies, University of Toyama

Background

The observation site introduced in this article is in Alaska, USA. Japan Agency for Marine-Earth Science and Technology (JAMSTEC), a research institute for Earth science in Japan, and International Arctic Research Center (IARC), University of Alaska Fairbanks (UAF) have been collaboratively developing hydro-meteorological and eco-hydrological studies by establishing a supersite for field experiments at a typical boreal forest in Alaska. This article introduces this Japanese contribution to the study on land surface process in a boreal climatic zone.

The JAMSTEC-IARC Collaboration Study (JICS) was launched in 2009 (Hinzman et al., 2013), and has continued into its second phase from 2014 to 2017. In 2010, a 17 m scaffold tower was constructed in the typical black spruce forest of Poker Flat Research Range (PFRR), a research facility of UAF located about 35 km northeast of Fairbanks city (Fig. 1). The tower is equipped with sensors for general meteorological measurements and fluxes of wind momentum, water vapor, and CO_2 in the atmospheric boundary layer.

Observations of soil respiration and snow are conducted near the tower which leads us to examine the fluxes in the soil-vegetation-atmosphere continuum with snow cover. This site also plays a role in acquiring the ground-truth values of vegetation for satellite remote sensing. The observations at this site are intensive and integrated by multidisciplinary purposes, and therefore, we can regard this site as a "supersite."

Geographical feature of the site

The geographical feature of the supersite in PFRR is summarized by Sugiura et al. (2011). The supersite is located in the zone of discontinuous permafrost and evergreen forest as displayed in Fig. 1. The topography of PFRR is characterized by a shallow valley bounded by hills (about 400 m a.m.s.l.) in its north and south sides, and the tower is constructed in the low and even land

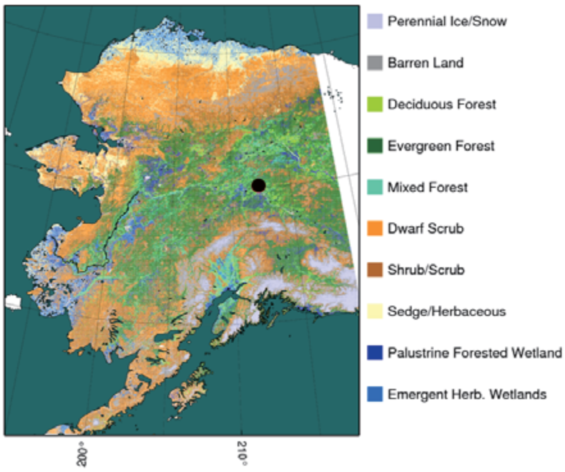

Fig. 1. Distribution of the land cover type according to National Land Cover Database 2001 (Homer et al., 2007) in Alaska. Black dot indicates the location of Poker Flat Research Range.

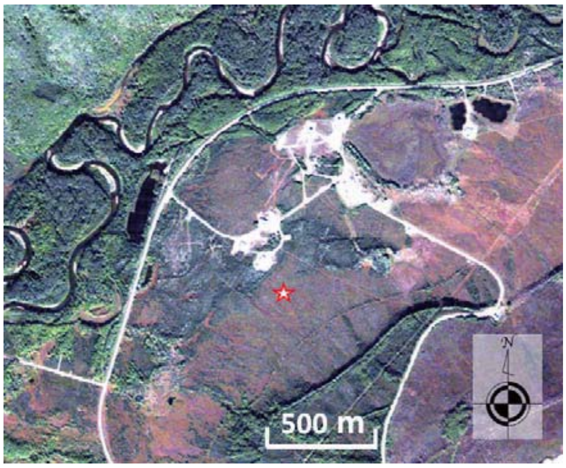

Fig. 2. True color image of Poker Flat Research Range by QuickBird (August 27, 2009) and the location of the scaffold tower of the supersite (red star).

Fig. 3. The 17m scaffold tower for eddy covariance and micrometeorological measurements in the black spruce forest in the property of the Poker Flat Research Range.

(65° 07' 24.4"N, 147° 29' 15.2"W; 210 m a.m.s.l.) (Fig. 2). Surface temperature inversion layer prevails in winter. The mean annual surface air temperature is below 0°C. In July, there are some days the temperature exceeds 20°C, while in winter the temperature frequently drops below -40°C. The land is homogeneously covered with forest of black spruce (*Picea mariana*), a typical forest in interior Alaska. The above ground biomass of the forest is about 10 Mg ha^{-1} (dry matter) (Suzuki et al., 2013) and the tree height is up to 6.5 m, which means the forest is considerably low and sparse. The forest floor is densely covered with sphagnum moss (*Sphagnum spp.*) on permafrost. Winds from ENE and WSW directions are prevailing throughout the year, while the mean wind speed in winter is lower than that in other seasons. Although the winter is characterized by a long calm frequency, strong ENE winds sometimes occur. The homogeneous and flat landscape is suitable for acquisition of the ground truth data for satellite remote sensing.

Eddy covariance and micrometeorological measurements

To better understand the carbon flow and stock within and beyond the boreal forest ecosystem, our study site hosts multiple flux and micrometeorological measurements at different vertical heights since October 2010. An eddy covariance (EC) system for CO_2 flux, sensible heat flux, and latent heat flux is equipped both above the canopy and within the canopy. The 17 m scaffold tower has an EC system at 11 m above the ground, 8 m above the mean canopy surface, and 5 m above the maximum canopy height (Fig. 3). The EC system within the canopy is equipped on a 1.9 m tripod securely installed 15 m away from the scaffold tower. Our EC systems contain an enclosed gas analyzer (LI-7200, LI-COR) that enables reliable measurements particularly throughout winter (Nakai et al., 2011). Gross primary productivity (GPP) calculated from CO_2 flux and latent heat flux (LE) measured within the black spruce canopy were 80% and nearly 100% of those measured above the canopy in 2011 (Fig. 4). Since half the black spruce canopy was located below 1.9 m, our conservative estimates on the understory contributions to GPP and LE were 60% and 100%, respectively.

Vertically multiple micrometeorological

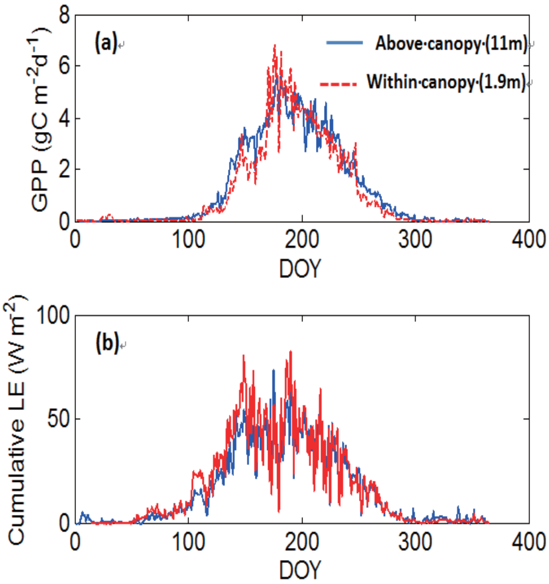

Fig. 4. (a) Daily gross primary productivity (g C m^{-2} d^{-1}) and (b) latent heat flux (W m^{-2}) measured within the black spruce canopy were 80% and nearly 100% of those measured above the canopy. Data were obtained in 2011 at the black spruce forest site in the Poker Flat Research Range.

measurements together with flux measurements (both eddy covariance and chamber measurements) provide useful information to investigate environmental controls on carbon and energy balance occurred at different ecosystem components, such as canopy leaves, understory plants, and soil. Winds and air temperature/humidity are measured at 8 different heights above the ground (3 points within the canopy), which also enables us to clearly observe unique micrometeorological characteristics within and above the boreal coniferous forest, such as temperature inversion in winter. Photosynthetically photon flux density and four components radiations (i.e., incoming and outgoing short-wave and long-wave radiations) are measured at two heights above and within the canopy, providing the information of the energy utilized in the ecosystem. For further information on the flux and micrometeorological elements, readers may refer to Nakai et al. (2013).

One of main goals for flux measurements is to link the information to remote sensing products. A phenological camera is mounted on the top of the scaffold tower continuously capturing the image of the canopy and understory (Nagai et al., 2013). Nagai et al., (2013) showed a strong correlation (R^2 = 0.86, p < 0.001) between daily green excess index computed from the image data and GPP estimated from EC measurements in 2012.

Acquired flux and micrometeorological data have been available to public (after 2 years of disclosure). Our site was registered with Ameriflux (US-Prr) in 2014 and the data up to 2012 have been uploaded as of December, 2014. Micrometeorological data are available from Ameriflux and also visible real-timely from the website of the IARC (http://www.iarc.uaf.edu/en/PFRR/data).

Soil respiration

The automated open/close chamber system (AOCCS) in the footprint of the scaffold tower consists of 16 soil chambers (30 cm high, 50 cm diameter), eight chamber bases (15 cm high, 50 cm diameter), a compressor for the chamber lid to open and close, a mini-pump (5 L min^{-1}), desiccant tube (3 cm ID, 20 cm long) filled with Drierite (Fisher Scientific, USA), CO_2 gas analyzer (Licor-820, LI-COR, Nebraska, USA), and two data-loggers (CR-10000, Campbell Scientific Inc., Lincoln, USA) for storage of CO_2 data and environmental data. The frame of the chamber was made of aluminum, and a transparent high-density polyethylene (HDPE) film was fixed to the frame with sealant. Two fans in each chamber are active for the homogeneous air sample when the lid is closed; the air is transported to the CO_2 gas analyzer and moved in a cycle by the pump. The targeted understory plants are dominant sphagnum moss, lichen, tussock tundra, and feather moss, as shown in Fig. 5.

Average net ecosystem exchange (NEE) and ecosystem respiration (RE) in the growing season were -0.039±0.025 and 0.127±0.049 mg CO_2 m^{-2} s^{-1} in tussock tundra, and 0.028±0.017 and 0.006±0.011 mg CO_2 m^{-2} s^{-1} in sphagnum moss, respectively, supporting tussock tundra is well-known as a source of atmospheric CO_2 (Kim et al., 2014; Kim, 2014). Air temperature is a more significant regulator than soil temperature in determining the GPP and Re of forest floor plants, explaining 77–95% of the variability in GPP and Re of the understory vegetation.

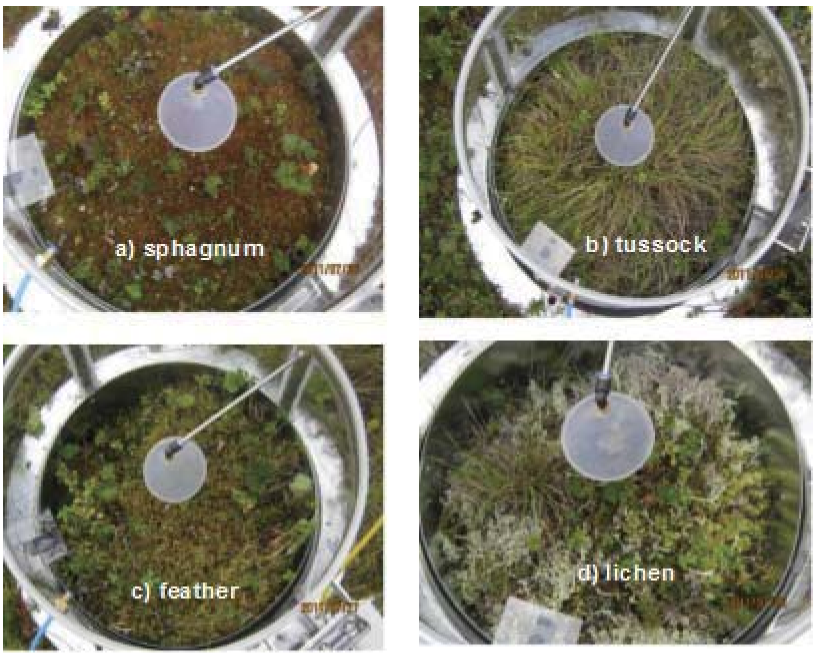

Fig. 5. Understory plants such as a) sphagnum moss, b) tussock tundra, c) feather moss, and d) lichen in JAMSTEC supersite of Poker Flat Research Range, University of Alaska Fairbanks.

Fig. 6. The snow pillow system at the supersite in Poker Flat Research Range.

Snow process in the boreal forest

Snow is one of the important processes for energy balance in the climate system. The lack of subgrid snow distribution and surface albedo representations in the boreal forest in most climate models has been identified as a deficiency in snow cover evolution and atmospheric interaction simulations. Widely observable satellite remote sensing technique also illustrates the uncertainties of subgrid snow distributions and surface albedo in the boreal forest. For better understanding snow processes in the Arctic climate system and for reducing the uncertainty of reliably estimating the amount of snow in the cryosphere, it is necessary to improve representations of non-uniform snow cover in the boreal forest within regional and global weather, climate, and hydrologic models.

We have installed observation instruments related to snow process at the supersite, such as 1) a snow pillow to measure snow water equivalent (Fig. 6), 2) sonic ranging sensors to measure snow depth, 3) interval cameras to record ground/snow surface conditions, 4) Pt100 sensors to measure a vertical profile of snow temperature, 5) soil temperature and soil moisture sensors to estimate relationship between snow and soil processes, 6) precipitation gauges to measure precipitation, 7) infrared radiometers to measure surface temperature, and 8) meteorological sensors to estimate energy balance. Elements related to snow process in the boreal forest have been observed and analyzed. The targeted temporal scale is mainly from daily to annual variations.

Inventory survey of forest

Near the tower, a forest plot with 30 m × 30 m rectangular area, was established, and the height and diameter at breast height (1.3 m) (DBH) of every tree stand more than 1.3 m were measured in 2010. There were 357 tree stands (equivalent to 3967 tree stands per hectare). Almost all the trees were black spruce. The highest tree stand was 6.4 m and the thickest DBH was 8.6 cm. The forest above-ground biomass (AGB) was 9.43 Mg ha^{-1} (dry matter). This survey of the forest inventory will be repeatedly executed to monitor the biomass change of the forest.

This forest plot has another role, that is, to acquire the ground-truth information of satellite remote sensing. The forest structure, position, height, and DBH of tree stands, are exhibited in Fig. 7. Based on this information of the forest structure, the forest 3D radative transfer model has been developed, and an attempt to estimate the accurate leaf area index of the forest by satellite data (SPOT VEGETATION) data is being conducted (e.g. Kobayashi et al., 2013). Also the forest AGB (9.43 Mg ha^{-1}) which was derived from the inventory survey will be a good ground truth data set for AGB estimation by spaceborne microwave synthetic aperture radar, such as Phased Array L-band Synthetic Aperture Radar (PALSAR) of Advanced Land Observing Satellite (ALOS) (e.g.

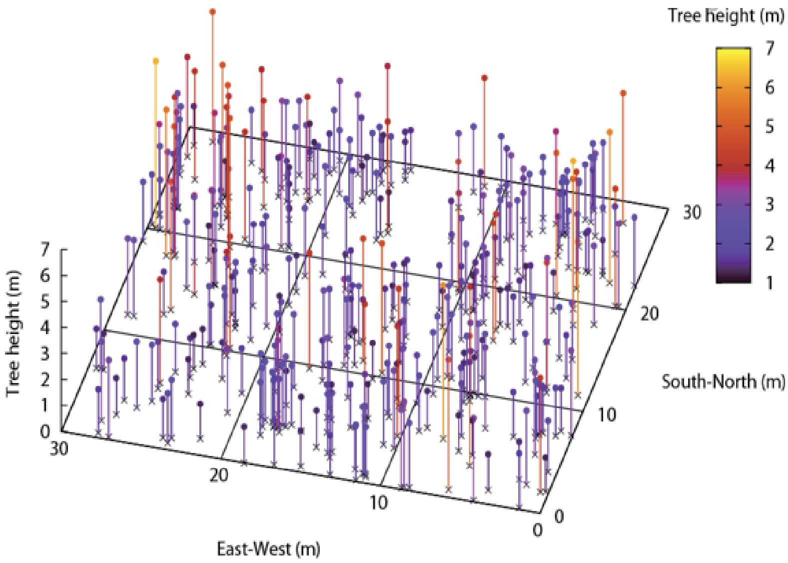

Fig. 7. The position and height of tree stands in the 30 m × 30 m forest plot of the supersite of Poker Flat Research Range in 2010. (Courtesy of Dr. Taro Nakai, Nagoya University)

Suzuki et al., 2013), and moreover, PALSAR2 of ALOS2.

Future prospect

The supersite in PFRR introduced here is well-equipped with hydro-meteorological sensors and has multidisciplinary targets such as sciences on atmosphere, hydrology, snow, ecosystem, and moreover, remote sensing. This supersite would be regarded as a representative site in boreal climatic zone in Alaska, which is similar to another supersite at Spasskaya Pad (Ohta et al., 2008) established by Japanese in boreal climatic zone in eastern Siberia. Comparison between two sites will bring ideas on the climatological and ecological differences between Alaska and eastern Siberia. It is strongly anticipated that the supersite at PFRR is maintained over a long time to reveal the climate and environmental changes of Alaska together with the supersite at Spasskaya Pad.

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ASIAFLUX WORKGROUP REPORTS

AsiaFlux has five workgroups: Short Course (SC), Measurement Standards (MS), Data Policy & Management (DP&M), Synthesis & Assessment (S&A) and Agora for Creative Thinking in Systems (ACTS) (http://asiaflux.net/?page_id=17). These workgroups were made in 2005 to activate AsiaFlux when Dr. Yoshikazu Ohtani was the chair of AsiaFlux, and then were partly modified in 2008 when Prof. Joon Kim was the chair. Tasks of the five workgroups include capacity development, measurement techniques, database and data sharing, and synthesis studies. All of these tasks are related to the significance of AsiaFlux. Members of the AsiaFlux Science Steering Committee (SSC) with additional AsiaFlux members are expected to play a leading role in each workgroup.

Now AsiaFlux has changed these ten years and situations surrounding AsiaFlux as well, it is time to review activities of the workgroups in the past and to make strategic plans for the future. This is why we prepared review and recommendation reports of the workgroups. We post those articles on the current issue of AsiaFlux Newsletter to share information with all the AsiaFlux members. The report by ACTS is expected to be in the next issue. Since we are going to discuss future plans in the SSC based on these articles, we welcome your comments and feedbacks.

Finally, we would like to thank working group members, who spared their precious time for writing the reports.

Report on the Short Training Course Working Group

Nobuko Saigusa[1], Kentaro Takagi[2], Xuefa Wen[3], Leiming Zhang[3], Sawako Tanaka[1]

[1] National Institute for Environmental Studies, Japan
[2] Hokkaido University, Japan
[3]Institute of Geographic Sciences and Natural Resources Research, CAS, China

Capacity building program based on short training courses, training workshops, and joint field practices, had been started since 2006 under the name of the Asiaflux, with financial supports from two distinct projects "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), and "Initiation of the next-generation AsiaFlux" by the Japanese Ministry of Education, Culture, Sports, Science and Technology (MEXT). The main targets of the program was originally to initiate eddy covariance measurements for energy, water vapor, and CO_2 flux sites and to grow the research communities for the sites in each country and region.

From 2007 to 2012, CarboEastAsia, a joint program among China, Korea and Japan, supported by the A3 Foresight Program (Japan Society for the Promotion of Science (JSPS), National Natural Science Foundation of China (NSFC), and National Research Foundation of Korea (NRF)), led the scientific activities and capacity buildings to integrate carbon and water flux measurements made in individual sites and to up-scale the results to regional and Asian scales. During the five years of the project, the training programs started covering international joint analysis and synthesis, and also joint field practices, for example, inter-comparison among different soil chamber measurements.

Since 2011, the capacity building programs have been planned and conducted depending on each target and need especially from other countries than China, Korea, and Japan, supported by APN (Terrestrial Ecosystem Flux Data in Tropics/ Subtropics and Croplands in Asia by Activating Regional Tower-based Observation Networks) from 2013. The targets were sometimes beginners, persons with observation experience of 2-3 years, and young scientists who seek conducting excellent science and writing better paper. The training courses for beginners have been effectively supported by sensor production companies such as LI-COR, Inc. (USA) and Campbell Scientific, Inc. (USA) accompanying the annual meeting of AsiaFlux (AsiaFlux Workshop) recently. The training workshops with students and researchers with experience of 2-3 years of observation are usually conducted with relatively small number of participants (< 15-20 persons) focusing on their own needs, e.g. long-term measurements and data analysis in Malaysia in 2012 and etc. Capacity building programs targeting on the writing paper together have been so far conducted mainly in East Asia (China, Korea, and Japan:please see Chinese training report in page 29). At present, new needs, such as training for CH_4 flux observation and data synthesis, have been emerging, and the first training course for CH_4 flux measurement was held in Bangladesh in 2014.

The outlines of the past training courses, training workshops, and field practices are listed below. Future direction and issue of the capacity building in AsiaFlux would be:

(1) Continue expanding observation sites and communities in serious 'blank area' in Asia such as in south and southeastern Asia, central Asia, Siberia and etc.

(2) Improve new observation techniques and skills for CH_4, N_2O, BVOC, and other trace gas emissions, and their QC/QA, and standardization

(3) Improve scientific level of Asian-scale international synthesis studies and to contribute to global communities more directly

There are still needs of hosting AsiaFlux capacity building programs in various countries and regions. Venue and target and how we organize the future capacity building programs would be suggested and discussed in the AsiaFlux members and in the SSC meetings depending on the needs. We would better share the discussion and direction of AsiaFlux capacity buildings as much as possible to international communities to enhance the visibility of the program, to enrich the collaborations among communities, and also, to assure future potential leaders of AsiaFlux training activities.

AsiaFlux Training Course 2006

Title: AsiaFlux Training Course 2006 on Micrometeorology – Theory and Practice of CO_2 Flux Measurement –

Date: August 21-30, 2006

Venue: Lectures: AIST Tsukuba, Japan

Field practice: Tsukuba NIAES site, Fujiyoshida FFPRI site and NIES site

Organizing committee

Saigusa N (AIST), Takagi K (Hokkaido Univ.), Murayama S, Wang H (AIST), Watanabe T (FFPRI), Hirata R, Liang N, Inukai K, Yuta S (NIES)

Financial support: MEXT, Japan

Program

Basic global warming, basic plant canopy micrometeorology, basic atmospheric boundary layer, sensors and flux measurements, theory of flux calculation, system maintaining, quality control & quality assurance, gap filling, flux calculation on PC, field study, and open seminar (trends and challenges in flux studies)

AsiaFlux Training Course 2007

Title: AsiaFlux Training Course 2007 on Micrometeorology – Theory and Practice of CO_2 Flux Measurement –

Date: July 17-26, 2007

Venue: Lectures: NICEM Seoul National University and Yonsei University, Korea

Field practice: Gwangneung KoFlux Supersite, Korea

Organizing committee

Bae R (NICEM), Kim J, Kim SJ, Lee D, Moon SK, Yuan R (Yonsei Univ), Saigusa N (AIST), Takagi K (Hokkaido Univ), Inukai K, Yuta S (NIES)

Financial support

Korean Ministry of Science and Technology, MEXT, Japan

National Instrumentation Centre for Environmental Management, Korea

Sustainable Water Resources Research Centre, Korea

Program

Basic global climate change, basic plant canopy micrometeorology, basic atmospheric boundary layer, sensors and flux measurements, theory of flux calculation, system maintaining, quality control & quality assurance, gap filling, flux calculation on PC, field study, and open seminar (trends and challenges in flux studies)

Joint Field Investigation 2008

Title : CarboEastAsia Joint Field Investigation "Field Campaign 2008"

Date: July 7 - 11, 2008

Venue : Fuji Calm, Fujiyoshida, Japan (Fuji Hokuroku Site, Fujiyoshida Site)

Financial support and organizing committee

CarboEastAsia (A3 Foresight Program)

Program

Inter-comparison of eddy flux calculation and QC/QA procedures of three flux networks (ChinaFLUX, JapanFlux and KoFlux) under AsiaFlux; comparison of soil CO_2 efflux measurement. comparison of LAI determination methods

Field Campaign in China 2009

Title : A3 Field Campaign in China

Date: July 27 - Aug 1, 2009

Venue: Xining, Qinghai Province, China (Xining and Haibei Alpine Meadow flux site)

Financial support and organizing committee

CarboEastAsia (A3 Foresight Program), ChinaFlux

Program

Fundamentals of the canopy-atmospheric boundary layer micrometeorology; flux calculation, data QC/QA, gap-fillings; methods of soil respiration and LAI measurements; theory and techniques for ecosystem carbon and water vapor isotope flux measurements; flux measurements and their connection to remote sensing technique and ecosystem models; field practice in Haibei Alpine Meadow Ecosystem Station

Field Campaign in Seoul 2010

Title : A3 Field Campaign in Seoul

Date: June 3, 2010

Venue: Yonsei University, Seoul, Korea (KoFlux Gwangneung Supersite)

Financial support and organizing committee
CarboEastAsia (A3 Foresight Program), KoFlux
Program
Interactive and in-depth discussions on the synthesis of the 3-year activities (i.e., standardization, data quality control, data use and data sharing policy for the database, model inter-comparison), outcomes and implications, plans for the 2nd Phase (2010-2012) with the extension

AsiaFlux Training Course 2011
Title: AsiaFlux Training courses in 2011 on Flux monitoring from Theory to Application
Date : July 11-15, 2011
Venue: Seoul National University, Korea
Organizing committee
AsiaFlux Short Courses Workgroup, KoFlux, and National Center for AgroMeteorology, Campbell Scientific, Inc.
Program
Lecture on canopy micrometeorology, eddy covariance technique, footprint analysis, and data processing. The applied lectures in parallel are plant physiology to flux measurement, new ecosystem science, flux mapping from tower to global, TERRECO application study, introduction of BVOC network, linking flux and isotope measurement, and uncertainty in eddy covariance measurement. Hands-on instrumentation sessions provide lectures and discussions on the practical flux measurement, data logger programs, and flux calculation along with practice sessions to improve skills on instrumentation, program coding, data processing, and site maintenance by Campbell Scientific, Inc.

Training Course during the AsiaFlux Workshop 2011
Title: Eddy Covariance Training by LI-COR 2011
Date: November 12-13, 2011
Venue: Universiti Teknologi Malaysia, Johor Bahru, Malaysia
Organizer
LI-COR, Inc. (USA), AsiaFlux
Program
LI-COR Eddy Covariance (EC) course including: understanding eddy covariance theory, system design, and applications; familiarize participants with the setting-up, operation, and maintenance of EC systems; understanding LICOR gas analyzers (operating theory, maintenance, calibration etc); and learning how to use EddyPro (software used to compute the eddy covariance flux), and also QA/QC .

AsiaFlux Training Course 2012
Title AsiaFlux short training seminar on data analysis for the eddy covariance method
Date 19-21 December 19-21, 2012
Venue Tropical Peat Research Lab, Sarawak, Malaysia
Organizer
Ibrahim AL (Univ. Teknologi Malaysia), Melling L (Tropical Peat Research Lab/CMD, Malaysia), Ueyama M (Osaka Pref. Univ., Japan), Saigusa N, Hirata R, Tanaka S (NIES, Japan), Hirano T (Hokkaido Univ., Japan)
Supported by
National Institute for Environmental Studies, Japan; iLEAPS Japan
Program
Lecture on flux calculations, Gapfilling, heat fluxes and discussions based on presentation by participants.

Training Course during the AsiaFlux Workshop 2013

Title: Eddy covariance LI-COR training during Joint Conference of 11th AsiaFlux International Workshop, 3rd HESSS (Hydrology delivers Earth System Science to Society) and 14th Annual Meeting of Korean Society of Agricultural Forest Meteorology (KSAFM)

Date August 19-20, 2013

Venue Seoul National University, Seoul, Korea

Organizer

LI-COR, AsiaFlux

AsiaFlux Training Course 2014

Title: AsiaFlux training & seminar on methane flux and carbon cycle

Date: February 23-27, 2014

Venue: Bangladesh Agricultural University, Mymensingh, Bangladesh

Organizer AsiaFlux

Baten MA (Bangladesh Agricultural Univ.), Miyata A (NIAES, Japan), Saigusa N, Tanaka S (NIES, Japan)

Sponsors (in alphabetical order): APN (Asia-Pacific Network for Global Change Research), Graduate School of Horticulture, Chiba University, Japan, LI-COR, NIAES Japan, NIES Japan

Program

Three-days LI-COR training on eddy covariance method and two-days seminar and presentations about methane flux monitoring in different countries in Asia and discussions based on presentations

Training Course during the AsiaFlux Workshop 2014

Title: Eddy Covariance Training by Campbell 2014: Monitoring net ecosystem-scale fluxes with eddy covariance and profile measurements during AsiaFlux workshop 2014

Date: August 18-19, 2014

Venue: International Rice Research Institute, Los Baños, Philippines

Organizer

Campbell Scientific Inc., AsiaFlux

Program

Theoretical considerations, data acquisition and measurement systems, flux instrumentation and measurement systems, OPEC System, CPEC200 System, AP200 System, data processing

AsiaFlux Training Course 2014

Title: AsiaFlux training and seminar on tropical ecosystem

Date: December 1-5, 2014

Venue: Cat Tien National Park, Vietnm

Organizer AsiaFlux

Kurbatova J (Vietnam Russia Tropical Centre (VRTC), Miyata A (NIAES, Japan), Saigusa N, Tanaka S (NIES, Japan), Nguyen Van Khue (VRTC), Nguyen Van Dien(Cat Tien National Park), Nguyen Dang Hoi (Institute for Tropical Ecology), Pham Huu Khanh (Cat Tien National Park) , Dinh Ba Duy (VRTC)

Sponsors (in alphabetical order): APN (Asia-Pacific Network for Global Change Research), Cat Tien National Park, LI-COR, NIAES Japan, NIES Japan, ileaps

Program

Three-days LI-COR training on eddy covariance method and one day seminar and presentations on ecological monitoring in different countries in Asia and discussions based on presentations.

Report on AsiaFlux Database, Policy, and Management Working Group

Nobuko Saigusa[1], Takashi Hirano[2], Jinkyu Hong[3], Sheng-Gong Li[4], Sawako Tanaka[1]

[1]National Institute for Environmental Studies, Japan
[2]Hokkaido University, Japan
[3] Yonsei University, Korea
[4]Institute of Geographic Sciences and Natural Resources Research, CAS, China

The AsiaFlux database was officially established in 2007 starting from sharing datasets provided by about ten flux sites in Asia. The timing of AsiaFlux database development was nearly the same as that various studies of energy, water, and CO_2 flux synthesis were growing. Results of the early stage synthesis studies including inter-site comparison and model-data synthesis had been published in the following special issues:

"Long-Term Carbon Exchange at the Takayama, Japan Forest", Agricultural and Forest Meteorology, Volume 134, Issues 1-4 (2005)

"Carbon Exchange Research in ChinaFLUX", Agricultural and Forest Meteorology, Volume 137, Issues 3-4 (2006)

"AsiaFlux Special Issue", Agricultural and Forest Meteorology, Volume 148, Issue 5 (2008)

"Water and energy exchange in East Siberian forest - East Siberian Climate SI", Agricultural and Forest Meteorology, Volume 148, Issue 12 (2008)

The number of data shared in AsiaFlux database had steadily increased since then. In particular, contributions from domestic and international projects in above mentioned synthesis were indispensable. They shared their quality-controlled datasets to the AsiaFlux database after the synthesis completed.

From 2007 to 2012, CarboEastAsia, the international joint project among ChinaFlux, KoFlux, and JapanFlux compiled their datasets throughout the Asia, and the number of the sites reached up to about 30 sites including forests, grassland, and agricultural fields. The project also produced gap-filled datasets, and almost all the data had been shared in the AsiaFlux database until now. The datasets established by CarboEastAsia and the main synthesis results had been published in the following special issues:

"CarboEastAsia Special Issue", Biogeosciences, Volumes 6-7, (2009-2010)

"Lessons learned from CarboEastAsia: Carbon and water cycles in East Asian terrestrial ecosystems", Journal of Forest Research, Volume 18, Issue 1 (2013)

The AsiaFlux database is open to the public through the website (https://db.cger.nies.go.jp/asiafluxdb/) with the datasets provided by 35 sites (November 2014). The datasets are now widely used by data providers' as well as community but also terrestrial ecosystem modelers and remote sensing scientists, contributing a number of synthesis. The monthly number of downloaded datasets was exceeded 200 site-year in 2013. The countries and regions that data users belong to were mainly in Asia (79%), followed by North America (12%) and Europe (4%) (Survey in November 2014).

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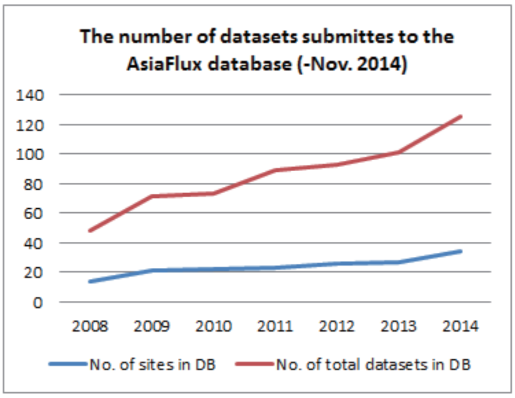
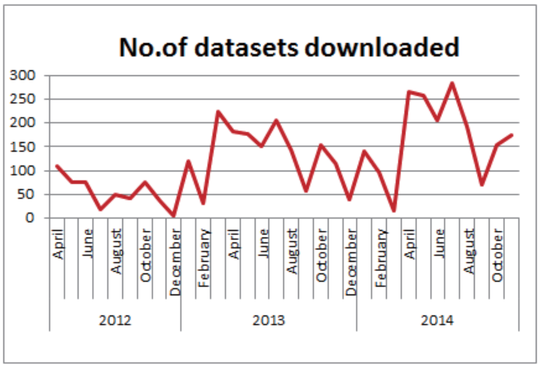
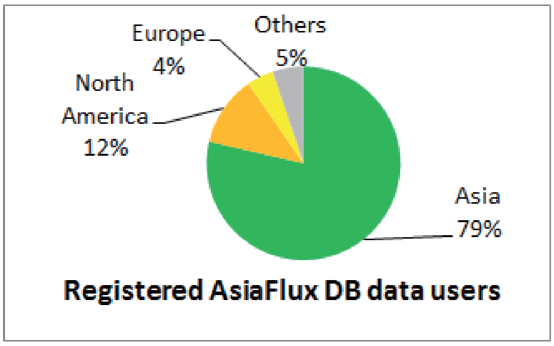


(a) Number of datasets (red line) and number of sites (blue line) registered in the AsiaFlux DB;



(b) Monthly number of datasets downloaded by uses



(c) Affiliation of the data uses registered in the AsiaFlux DB (up to November 2014).

AsiaFlux Database website (https://db.cger.nies.go.jp/asiafluxdb/)

Data

Site Name (Link to AsiaFlux Site Information)	Data (Link to data)
Bukit Soeharto (BKS)	FxNt 2001, 2002
Xishuangbanna Site (BNS)	FxNt 2003-2005
Changbaishan Site (CBS)	FxNt 2003-2005
Chi-Lan Mountain Research Site (CLM)	FxNt 2007-2009
Fujiyoshida forest meteorology research site (FJY)	FxNt 2000 / GfNr 2000 / SoRe 2003, 2004
Fuji Hokuroku Flux Observation Site (FHK)	FxNt 2006-2009
KoFlux Gwangneung Supersite - Coniferous forest (GCK)	FxNt 2007, 2008
KoFlux Gwangneung Supersite - Deciduous forest (GDK)	FxNt 2004-2008
Haibei Potentilla fruticosa bush Site (HBG)	FxNt 2003-2004
KoFlux Haenam site (HFK)	FxNt 2004-2006, 2008
IRRI Flux Research Site (IRI)	FxNt 2009, 2010
Kherlenbayan Ulaan (KBU)	FxNt 2003-2009
Laoshan (LSH)	FxNt 2002
Moshiri Birch Forest Site (MBF)	FxNt 2003-2005
Mae Klong (MKL)	FxNt 2003, 2004
Moshiri Mixed Forest Site (MMF)	FxNt 2003-2005
Mase paddy flux site (MSE)	FxNt 2001-2006
Palangkaraya drained forest (PDF)	FxNt 2002-2005, GfLt 2002-2005
Pasoh Forest Reserve (PSO)	FxNt 2003-2009, GfNr 2003-2009
Qinghai Flux Research Site (QHB)	FxNt 2002-2004, GfNr 2002-2004
Qianyanzhou Site (QYZ)	FxNt 2003-2004
Sakai City Office (SAC)	FxNt 2009
Sakaerat (SKR)	FxNt 2001-2003
Southern Khentei Taiga (SKT)	FxNt 2003-2006
Seto Mixed Forest Site (SMF)	FxNt 2002-2006
KoFlux Seolmacheon site (SMK)	FxNt 2008
Takayama evergreen coniferous forest site (TKC)	FxNt 2007
Takayama deciduous broadleaf forest site (TKY)	FxNt 1998-2007 / SoRe 1995, 1999-2002
Tomakomai Flux Research Site (TMK)	FxNt 2001-2003
Teshio CC LaG experiment site (TSE)	FxNt 2001, 2002, 2004-2012 / GfNr 2001, 2002, 2004, 2005
Tura (TUR)	FxNt 2004
Taiwan Fuisun Forest Station (TWF)	FxNt 2011-2013
Yucheng Site (YCS)	FxNt 2003-2005
Siberia Yakutsk Larch Forest Site (YLF)	FxNt 2003-2007
Yakutsk Pine Forest Site (YPF)	FxNt 2004-2007

Update History

- BNS 2003-2005, CBS2003-2005, HBG2003-2004, QYZ2003-2004 and YCS 2003-2005 are added (2014 August 12)
- SAC 2009 is added. (2014 August 6)
- TSE 2006-2012 is added. (2014 July 31)
- TWF 2011-2013 is added (2014 April 7)
- PSO 2003-2009 is updated (2014March 4)
- FHK 2006-2009 MSE 2006 are added (2013 October 3)
- IRI 2009-2010 is added (2012 May 28)

The lists of datasets in AsiaFlux database and the recent update history (at November 2014)

One of the important future issues of the AsiaFlux Database would be its Fair Use Policy. The current data policy stipulates that the data provider must be informed and his/her/their approval obtained before submitting any publication using the data downloaded from AsiaFlux Database. This data policy is necessary not only for flourishing scientific interpretation based on site-specific information, but also for improvement of the AsiaFlux database for future synthetic studies. We highly recommend users to communicate with the data providers before publications and to focus on more synthetic studies based on AsiaFlux. The data use should be tracked to facilitate active interactions between scientists.

Another important issue is the open and free access of data. This open-access is for promoting public education and scientific collaboration. More and more communities have been adopting the open-access data policy and FLUXNET will also release new data policy based on the open-access of data soon. This is, however, challenging in Asian community and urgently, we should collect our ideas to give proper benefits to the data providers with such changes in the data policy.

AsiaFlux Database Fair Use Policy

Data Requesting Form to download the dataset

Synthesis and Assessments of Carbon and Water Budget: Current and Future Aspects

[1]Kazuhito Ichii, [2]Weimin Ju, [3]Cheng Ke-Sheng, [4]Guangsheng Zhou, [5]Shuli Niu, [6]Young-Hee Lee, [7]Derrick Y. F. Lai

[1]Japan Agency for Marine-Earth Science and Technology, Yokohama, Japan, and National Institute for Environmental Studies, Tsukuba, Japan
[2]Nanjing University, Nanjing, China
[3]National Taiwan University, Taipei, Taiwan
[4]Chinese Academy of Meteorological Sciences (CAMS), China Meteorological Administration (CMA), P. R. China
[5]Institute of Geographic Sciences and Natural Resources Research, Chinese Academy of Sciences
[6]Kyungpook National University, Daegu, Republic of Korea
[7]The Chinese University of Hong Kong, Hong Kong SAR, China

Synthesis and assessment of carbon and water measured at various sites and based on various techniques are important to estimate terrestrial carbon and water budget and their responses to environmental changes at large scales. Site observation, satellite observation, and models are examples of approaches commonly used for synthesis (e.g. Figure 1). Indeed, many studies have attempted to estimate terrestrial carbon budget in Asia using these methods and showed that large variations exist among methods. A part of the reason is a network data of eddy-covariance observation has not been effectively used. AsiaFlux database could serve as the important input to such synthesis and assessment activities and therefore contribute to improving our understanding of terrestrial carbon budget and underlying mechanisms. Current synthesis works consist of (1) analysis of multiple site data, (2) upscaling using AsiaFlux and remote sensing data, (3) terrestrial ecosystem model evaluation using observations, (4) country and continental scale carbon budget estimation using multiple methods, and (5) data-model fusion to improve model performance.

Site-level synthesis and assessments have been conducted in many works using multiple tower observation data in the past 10 years. Using the AsiaFlux database, Saigusa et al. (2008) and Hirata et al. (2008) conducted cross-site synthesis study using data of about 10 sites. These studies highlighted the important aspect that the climate gradients are related to the carbon budget gradients from tropical forests to boreal forests. In addition, Wang and Zhou (2012) reported the light use efficiency (LUE) on a typical steppe and a desert steppe in Inner Mongolia, northern China, suggesting that the use of a biome-dependent LUEmax is inappropriate, because of the large inter-site difference of LUEmax. Yu et al. (2013) showed wide divergence of eddy-covariance observations in ChinaFlux. As an output of 'CarboEastAsia project' during 2007-2012, Saigusa et al. (2013) reported the new data sets of 26 sites, and highlighted the spatial patterns in carbon budget in Asia. Yu et al. (2014) revealed the large C sink in the subtropical forest in East Asia, which is equivalent to the two well-known largest C sinks in Northern America and Europe.

The establishment of a consistently pre-processed database of eddy-covariance observation enables us to conduct empirically upscaled estimation (data-driven estimation) of terrestrial carbon

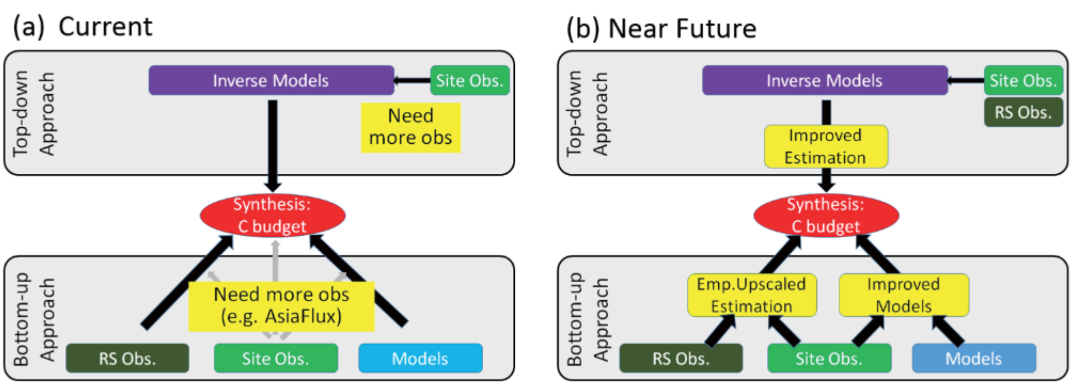


Figure 1. (a) Current and (b) Near future aspects for the synthesis activity towards better estimation and understandings of terrestrial carbon fluxes in Asia region.

fluxes. Empirical upscaling is one of approaches for the synthesis based on site observation and satellite remote sensing. These techniques have advantages that combine purely empirically driven estimation with remote sensing data, and provide an independent estimation of spatio-temporal variations in terrestrial carbon fluxes. In Asia region, Ichii et al. (2010) provided an estimate of gross primary productivity using four eddy-covariance flux observation sites in Japan. Saigusa et al. (2010) provided a spatial map of gross primary productivity in East and Southeast Asia, and analyzed the spatial differences of GPP responding to the meteorological anomalies in 2003 summer.

The eddy-covariance data can also be used to evaluate the terrestrial biosphere models. The model comparison activities are generally called as 'Model Intercomparison Project; MIP'. In Asia, two MIP activities related to carbon cycle were conducted. In the first stage, Ichii et al. (2010) conducted an evaluation of terrestrial biosphere model using 4 JapanFlux observation sites. These studies found that the models overall poorly simulate terrestrial carbon budget and fluxes at these sites, and the interannual variation is rather consistent among models. Ichii et al. (2013) compared 7 terrestrial biosphere models in Asia, and found that model and observation mismatch occurs mainly in the tropical forests, and cropland, implying requirement of further model refinements. The Terrestrial Ecosystem Model (TEM) was validated based on the four field sites with eddy-covariance observations in Chinese temperate grasslands (Sui and Zhou, 2013), and the sensitivity experiments further revealed that precipitation variability was the primary factor for decreasing carbon storage (Sui et al., 2013).

At country level, many research groups in China and Japan have attempted the country level estimation of terrestrial carbon budget mostly. In China, many studies were published for the country-based carbon budget estimates. Various techniques have been applied for this purpose; e.g. InTEC ecosystem model by Ju et al. (2007), multiple models approach by Piao et al. (2009), and TEM model by Tian et al. (2011). In Japan, Ito (2008) and Sasai et al. (2011) estimated carbon budget in Japan using VISIT and BEAMS models, respectively. Ichii et al. (2010) estimated it using ensemble of 8 different terrestrial biosphere models. Yoo et al. (2013) estimated carbon budget in Korea using VISIT model.

Recently, Regional Carbon Cycle Assessment and Processes (RECCAP) released current estimates of sub-continental scale terrestrial carbon budget. Carbon budgets in East Asia (Piao et al., 2013), South Asia (Patra et al., 2013), and Russia (Dolman et al., 2012) were analyzed as the regions based on AsiaFlux sites databases. The RECCAP synthesized the carbon budget and its uncertainty using different methods, including top-down estimations, empirical estimations using site observation, terrestrial ecosystem models, and other datasets. These were the first attempt to evaluate terrestrial carbon budget at regional and global scales. These studies reported the consistency and differences among each budget estimation methods. Overall, the different estimation approaches show a good agreement in estimating carbon budget. However, these are still considered as very preliminary. For example, these estimations provided only the mean carbon budget at sub-continental scales, but its mechanisms and spatio-temporal variations were not well analyzed, and observation data such as AsiaFlux were not used in these analysis.

Data-model fusion is one of the effective approach to improve the performance of carbon and water cycle simulations using available observation data. Parameter optimization and data assimilation are common approaches. Ju et al. (2010) applies a data assimilation technique, ensemble Kalman filter, optimizing the BEPS terrestrial ecosystem model with observed GPP and LE at Qianyanzhou ecological station in southeastern China and confirmed model improvements. The study further analyzed the seasonal and interannual variations in the estimated model parameters. Ito (2010) applied model parameter optimization to inversely estimate typhoon-induced defoliation intensities using VISIT terrestrial ecosystem model and observed carbon fluxes at the Takayama deciduous broadleaf forest site. Kondo et al. (2015) inversely estimated carbon allocation ratio to fine root component using Biome-BGC terrestrial ecosystem model with observed carbon fluxes and inventory (e.g. carbon pools), and evaluated its interannual variation. At this stage, most of the model-data fusion works are limited to data of one or a few sites, and further efforts is required to apply these methods to the regional to continental scales to refine carbon and water budget estimations. For example, empirically upscaled products (Ichii et al. 2010; Saigusa et al. 2010) are one of the good candidates (e.g. Ichii et al. 2009).

To improve our understanding of the terrestrial carbon cycle in Asia, tremendous efforts are still required. First, the eddy-covariance data should be carefully used and spatial representativeness of site data should be assessed. Second, we need more comprehensive analysis of the data, especially for the long-term observation data. Currently, the observation data are mostly limited to a few years. Long-term data can be used to detect interannual variations and the controlling mechanisms. Third, integrated analysis of ecological observations and biometric data such as biomass and soil carbon pools, in addition to fluxes, are required for more comprehensive understanding. Fourth, cropland and disturbance events should be analyzed more in details, since these are important and unique characteristics to Asia. As an example, Zhang et al. (2014) proposed a forest age map in China, which should be an important dataset to understand the carbon cycle of forests. Fifth, estimation based on techniques other than eddy-covariance based CO_2 fluxes such as soil respiration and fluxes of CH_4 and other trace gases should be analyzed and synthesized. These observation networks are rapidly growing, and the synthesis across sites should be an important and effective approach to understand terrestrial carbon budget.

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Report on Measurement Techniques and Standards Working Group

Shenggong Li, Xuefa Wen, Leiming Zhang

Synthesis Research Center for Chinese Ecosystem Research Network;
Key Laboratory of Ecosystem Network Observation and Modeling, Chinese Academy of Sciences, CAS;
Institute of Geographic Sciences and Natural Resources Research, CAS;
A11 Datun Road, Chaoyang District, Beijing 100101, China

Within the AsiaFlux community, much attention has been given to the measurement techniques and standards that relate to the eddy covariance approach since 2006. As an integral part of the short training courses, and training workshops, some field campaigns have been conducted to make comparisons of different equipments such as eddy isoflux measurements, and soil efflux measurements. These activities are partially supported by the A3 Foresight Program of CarboEastAsia: “Capacity building among ChinaFLUX, JapanFlux and KoFlux to cope with climate change protocols by synthesizing measurement, theory and modeling in quantifying and understanding of carbon fluxes and storages in East Asia”. This project was jointly supported by Japan Society for the Promotion of Science (JSPS), National Natural Science Foundation of China (NSFC), and National Research Foundation of Korea (NRF) (http://www.carboeastasia.org/).

As one of members of AsiaFlux, ChinaFLUX has been active in holding eddy flux training course since its establishment, totally nine short training courses have been held as of 2014 (Table 1, and Photo plates).

Isotopic measurements of CO_2 and water vapor can help improve our understanding of underlying physiological and ecological mechanisms constraining ecosystem carbon and water exchanges, and provide especially a powerful tool to partition net ecosystem CO_2 exchange and evapotranspiration into their components. In recent years, eddy isofluxes of CO_2 and water vapor in ChinaFLUX have been measured over forest, grassland, cropland and urban ecosystems by using the Isotope

Date	Location	Course	Support partner
20-22 April 2008	Beijing	The 6th ChinaFLUX Training Course	CarbonEastAsia
28-31 July 2009	Xining	The 7th ChinaFLUX Training Course	CarbonEastAsia
22-24 April 2013	Beijing	The 8th ChinaFLUX Training Course on Eddy-Covariance	Compbell Scientifc inc., USA
22–25 September 2014	Beijing	The 9th ChinaFLUX Training Course & Arbonaut User Days 2014	Arbonaut inc., Finland

Table 1 List of ChinaFLUX Training Course since 2008

Photo 1. The 7th ChinaFLUX Training Course

Photo 2. The 8th ChinaFLUX Training Course

Photo 3. The 9th ChinaFLUX Training Course

ratio infrared spectroscopy (IRIS). The IRIS provides an in situ technology for measuring δ18O and δD of water vapor and δ13C in atmospheric CO_2. In ChinaFLUX, we have demonstrated the feasibility to simultaneously measure both δ18O and δD in atmospheric water vapor using tunable diode laser absorption spectroscopy (TDLAS), wavelength-scanned cavity ring-down spectroscopy (WS-CRDS), and off-axis integrated cavity output spectroscopy (OA-ICOS) (Wen et al., 2008, Journal of Hydrology; Wen et al., 2012, Journal of Atmospheric and Oceanic Technology) An inter-comparison experiment was carried out with the above-mentioned commercial IRIS analyzers to characterize their performance and transferability of calibration methods. These analyzers tracked the natural variability in ambient conditions very well and achieved an average difference between one another within 2‰ for δD and within 0.1‰ for δ18O after calibration at appropriate frequencies. The δD measurements were less prone to concentration dependence errors than the δ18O measurements. The concentration dependence underscores the importance of using a calibration procedure at multiple mixing ratios to bracket the range of natural variability. Meanwhile, in ChinaFLUX, in situ and continuous observations of δD and δ18O of atmospheric water vapor have been performed at the surface air in Beijing (Figure 1, Wen et al., 2010, Journal of Geophysical Research–Atmospheres; Zhang et al., 2011, Journal of Geographical Sciences), a winter wheat and summer maize cropland in Luancheng (Wen et al., 2012, Oecologia; Xiao et al., 2012, Global Change Biology), a grassland in Duolun (Hu et al., 2014, Journal of Geophysical Research– Biogeosciences), a spring maize cropland (Figure 2, Huang and Wen, 2014, Journal of Geophysical Research–Atmospheres) and a subtropical coniferous plantation (Yang et al., 2015, Agricultural and Forest Meteorology).

A number of methods have been proposed for calibrating the IRIS measurements for measuring δ13C in atmospheric CO_2, but few studies have systematically evaluated their accuracy for atmospheric applications. In ChinaFLUX, both laboratory and ambient measurements were carried out with two commercial IRIS analyzers and compared the accuracy of different calibration strategies (Figure 3, Wen et al., 2013, Atmospheric Measurement Techniques). It was found that calibration based on the 12C and 13C mixing ratios (Bowling et al., 2003) and on linear interpolation of the measured delta using the mixing ratio of the major isotopologue (Lee et al., 2005) yielded accuracy better than 0.06 ‰. However, even after calibra-

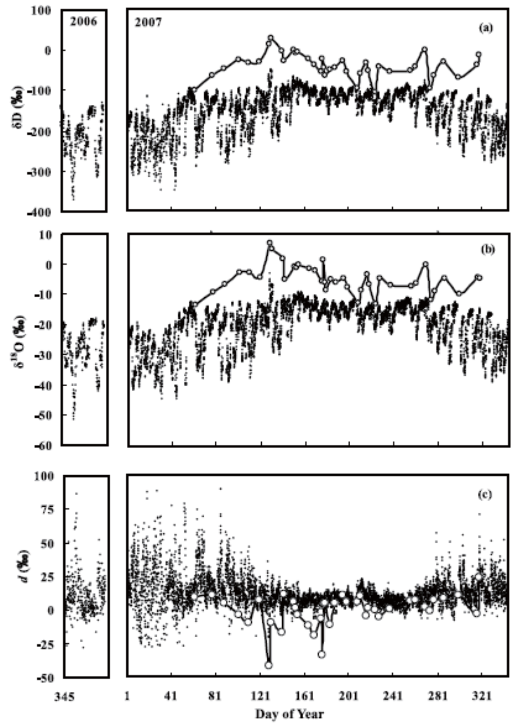

Figure 1. Hourly values of (a) δD, (b) δ18O, and (c) deuterium excess (d) of atmospheric water vapor (dots) and precipitation (circles) from December 2006 to December 2007 in Beijing, China (Wen et al., 2010, Journal of Geophysical Research–Atmospheres).

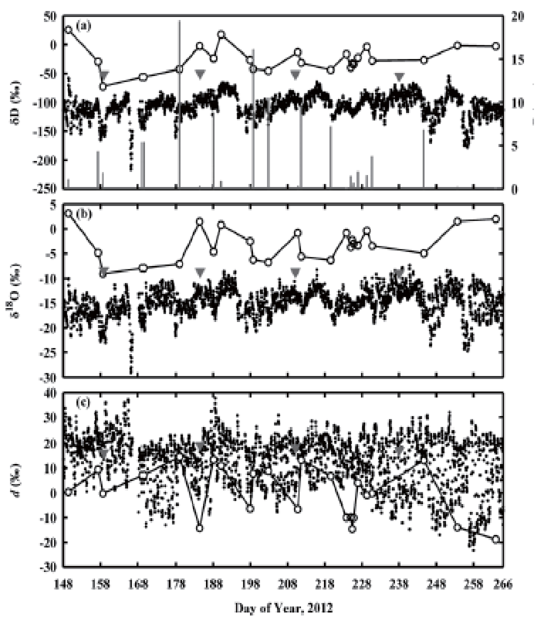

Figure 2. Hourly values of (a) δD, (b) δ18O, and (c) deuterium excess (d) of atmospheric water vapor (dots) from 27 May 2012 to 22 September 2012 in Zhangye, China. The isotopic ratios (circles) and amounts (columns) of event-based precipitation and isotopic ratios (triangles) of irrigated water are also shown (Huang and Wen, 2014, Journal of Geophysical Research–Atmospheres).

tion the difference between the two analyzers showed a slight correlation with concentration, and this concentration dependence propagated through the Keeling analysis, resulting in a much larger difference of 2.44‰ for the Keeling intercept. The high sensitivity of the Keeling analysis to the concentration dependence underscores the challenge of IRIS for atmospheric research.

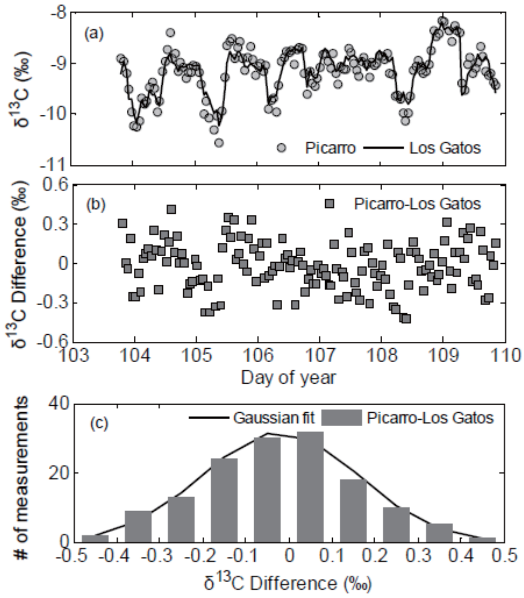

Figure 3. Time variations of (a) hourly atmospheric _δ13C in Beijing during DOY 103-110 in 2012, (b) difference between the Picarro G1101-i and the Los Gatos DLT-100 analyzer, and (c) histogram of the differences (Wen et al., 2013, Atmospheric Measurement Techniques).

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Amnat Chidthaisong
(Joint Graduate School of Energy and Environment, King Mongkut's University of Technology Thonburi, Thailand)

AsiaFlux Secretariat in Tsukuba
Center for Global Environmental Research
National Institute for Environmental Studies
16-2 Onogawa, Tsukuba 305-8506, Japan
Ph: +81-29-850-2971
Fax:+81-29-858-2645
E-mail: tsukuba@asiaflux.net

AsiaFlux Newsletter is only available on the AsiaFlux Website: www.asiaflux.net

From Editor

I feel honored to be guest editor of this current Asiaflux newsletter. In this volume, introduction on supersite in Alaska is of particular interest and this provides some new perspectives to flux communities. Reports on various aspects/activities successfully carried out by AsiaFlux provide insights into many aspects of scientific developments in the AsiaFlux communities. As an Editor, I hope this information is useful and inspires our community to enhance/enrich our collaboration in the future. Putting these contents together would not be possible without the contributions from all authors, and the pushes by the AsiaFlux Secretary, Ms. Sawako Tanaka. I would like to thank you all for your hard works and great valuable contribution.