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Report on the Joint Conference of 11th AsiaFlux International Workshop, 3rd Hydrology delivers Earth System Science to Society (HESSS), and 14th Annual Meeting of Korean Society of Agricultural and Forest Meteorology -19 ~ 24 August 2013, Seoul, Korea-

Minseok Kang and Conference Organizing Committee

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While the boundaries between academics have become blurred, the integrations of academic disciplines for (re) solving the questions facing humanity, are not something that started just recently. For example, one of the 'Millennium Prize Problems', the Poincaré conjecture was proven by Grigori Perelman through integrations of various academic disciplines such as topology and physics, not only mathematics. In this context, a joint conference among different scientific communities is no longer an uncommon attempt. The joint conference between AsiaFlux and HESSS (Hydrology delivers Earth System Science to Society), which had been initiated during the 2nd HESSS-AsiaFlux Symposium at the University of Tokyo in 2010, was finally held in Seoul National University (SNU) from 21 to 24 August 2013 together with Korean Society of Agricultural and Forest Meteorology (KSAFM) (Fig. 1).

As pointed out in the welcome address from chair and vice chairs of AsiaFlux, the purpose and necessity of the joint conference are as

Fig. 1. A group photo of the joint conference

follows. The theme was "Communicating Science to Society: Coping with climate extremes for resilient ecological-societal systems." Humanity has emerged as a major force in the operation of the biosphere, challenging ecological-societal resilience. This urgent situation necessitates a fundamental shift in our perspectives, worldviews, and institutions. The organizing committee hoped that the joint conference would provide a great opportunity for scientists, practitioners, and the public (1) to better understand the latest scientific achievements and (2) to help develop educational, technical, and socio-economic options to reconnecting to the biosphere and becoming active stewards of the Earth Systems as a whole.

The joint conference was co-hosted by National Center for AgroMeteorology (NCAM) and Interdisciplinary Program in Agricultural and Forest Meteorology (AgFM) in SNU, and sponsored by Asia-Pacific Network for Global Change Research (APN), Institute of Geographic Sciences and Natural Resources Research, Chinese Academy of Sciences (IGSNRR, CAS), Korea Forest Service (KFS), Korea Meteorological Administration (KMA), Korean Meteorological Society (KMS), Korean Research Institute of Standards and Sciences (KRISS), LI-COR Biosciences, Inc., NCAM, National Institute for Agro-Environmental Sciences (NIAES), National Institute for Environmental Studies (NIES), Rural Development Administration (RDA), SNU, and the University of Tokyo. More than 200 scientists and students participated in the joint conference from 24 countries, and we had 120 oral and 60 poster presentations.

Pre-Conference Training Courses

Prior to the joint conference, intensive training courses on flux measurement were held in SNU from 19 to 20 August 2013 (Fig. 2). The training courses were hosted by LI-COR Biosciences, Inc. and SNU. About 50 young scientists and students from 13 countries participated in the training courses. The participants were trained for (1) understanding eddy covariance theory, experimental design and applications, (2) understanding operation theories of gas analyzer and sonic anemometer, (3) being able to set up and operate eddy covariance systems, and (4) being able to process raw flux data with EddyPro® (eddy covariance data processing application).

Welcoming and Opening Session

On the first day, there were welcome addresses from the representatives of the hosts and the academic communities (Profs. Hak-Lae Lee, Taikan Oki, Man Yong Shin, Eun Woo Park, and Joon Kim). After the welcome addresses, Prof. Joon Kim (Intro: taking stock & looking ahead) introduced the purposes, vision and key questions of the joint conference.

Plenary Sessions

During the first plenary session, Dr. Ray Leuning (Communicating (climate) science), Prof. Murugesu Sivapalan (Socio-hydrologic modeling to understand and mediate the competition for water between humans and ecosystems: Murrumbidgee river basin, Australia), and Prof. Benjamin Ruddell (Better understanding of complex coupled human natural systems: New approaches and concepts) presented their concerns on 'Communicating science to society.' We identified the challenges on how to integrate our researches into society and the possibility of new approaches and concepts. During the second plenary session (Coping with climate extremes), two keynote speeches were provided by Prof. Hugo Berbery (Droughts in southern South America: large-scale dynamics and regional processes) and Dr. Markus Reichstein (Climate extremes and its impacts on the carbon cycle), in which the impacts of climate extremes (e.g., droughts) on the ecological-societal systems were discussed. During the third plenary session, Prof. James Famiglietti (Water cycle change and the human fingerprint on the water landscape) and Prof. Taikan Oki presented about the recent research progresses in 'Water and food security.'

Break-out Sessions

There were break-out sessions of three communities on the second day and the third day morning. For AsiaFlux, there were 67 presentations in the eight sessions (i.e., Linking regional flux networks; Effects of climate extremes and human disturbances on ecosystems; Current issues in flux monitoring; Carbon tracking in Asia; Challenges in quantifying greenhouse gas emissions across soil surface; Communicating carbon and water science to society; Tropical and subtropical ecosystems: vulnerability and resilience; Process studies from leaf to canopy). For HESSS, there were 19 presentations in the four sessions (i.e., Recent progresses in hydrologic simulations; Capacity building with new data and methods; Natural and human-induced changes of hydrologic cycles; Understanding water and carbon dynamics). For KSAFM, there were 11 presentations in the two sessions (i.e., Networking ecological observation and modeling in Korea; Biometeorological modeling and assessment). In each session, the speakers presented about the recent research progresses and the participants conducted in-depth discussions about the issues.

Joint and Special Sessions

On the third day, there were two joint sessions between AsiaFlux and HESSS (i.e., Human society, history, and water in changing world; Bridging the gap between local measurement and large scale modeling) and two joint sessions between Integrated Land Ecosystem-Atmosphere Processes Study (iLEAPS) and other research programs (e.g., iLEAPS/IGAC/WMO joint initiative: interdisciplinary biomass burning initiative (IBBI) – Asian perspective; iLEAPS/GLP/AIMES joint initiative: Interactions among managed ecosystems, climate, and societies (IMECS) – Asian perspective). As an extension of training courses, there was a special session from LI-COR Biosciences, Inc. on using the EddyPro® program.

Fig. 2. A group photo of pre-conference training courses

Fig. 3. Young scientist meeting

AsiaFlux Science Steering Committee Meeting and Young Scientist Meeting

On the second evening, there were AsiaFlux Science Steering Committee meeting (SSC) and Young Scientist meeting (YSM). In the SSC, International Rice Research Institute (IRRI, Philippines) was chosen to host the 2014 AsiaFlux workshop, and the schedules of other conferences and training courses were discussed. The 2013 joint YSM of AsiaFlux, HESSS, and KSAFM had more than 60 young scientists from 19 countries (Fig. 3). Especially, we were pleased to have nine guests (i.e., seven plenary session speakers and two senior researchers such as Drs. Yoshinobu Harazono and Kazuhito Ichii) attended the meeting and share their valuable experiences in research and life. The number of guests was the largest since 2007.

Poster and Closing Sessions

We had about 60 poster presentations. It was the first time in AsiaFlux workshop to select the outstanding student posters. The winners were Mr. Juhan Park (Estimation of changes of carbon balance after thinning of 50-year-old Pinus Koraiensis stands with sap flux measurements), Mr. Tserenchunt Battumur (Estimating change of inter-annual green-up variability in Mongolia), and Mr. Sung-Hyun Min (Soil respiration in rice and barley double cropping paddy-field in Korea), and the participants celebrated winning the awards during the closing session. There were rapporteur's sessions reporting the summary and synthesis of individual sessions held during the joint conference. They reported: (1) brief descriptions of major concerns, (2) major findings to communicate to science community, and (3) key message to communicate to the society for each session. The participants, organizing committee and staffs celebrated the success of the joint conference and promised to meet again at the next joint conference in 2016 in California, USA.

Field Excursion

During the joint conference, AsiaFlux and iLEAPS laid the groundwork for their collaboration researches: iLEAPS-Korea was newly launched and there were the joint sessions between iLEAPS and the other research programs. In this context, destination of field excursion was the main research site of iLEAPS-Korea, Taehwasan University Forest, which is composed of 497 ha of natural hardwood forest and 300 ha of pine plantation (Fig. 4). Profs. Meehye Lee and Hyun-Seok Kim introduced the research sites and ongoing researches in Taehwasan University Forest.

In this joint conference, there were many novel approaches in AsiaFlux workshop: (1) submission of the session proposals, (2) maximum five parallel sessions, (3) session rapporteurs (the participants can obtain summaries of the missed sessions), (4) on-line participation and presentation via Skype from other flux network (Prof. Dennis Baldocchi from FLUXNET and Dr. Eva van Gorsel from OzFlux; for linking AsiaFlux to the other flux networks), (5) pre-conference training courses (offering the trainees an opportunity to experience what they learned), (6) outstanding student poster awards (an extra incentive for students), (7) luncheon movie, and (8) web based payment system (it was convenient for not only staffs but also participants). The organizing committee hopes that these new attempts will continue in our future AsiaFlux workshops as more developed forms. The organizing committee appreciates the financial supports from sponsors mentioned above, and the participants from all over the world. We would like to specially thank the staffs for their devotion to manage the joint conference successfully.

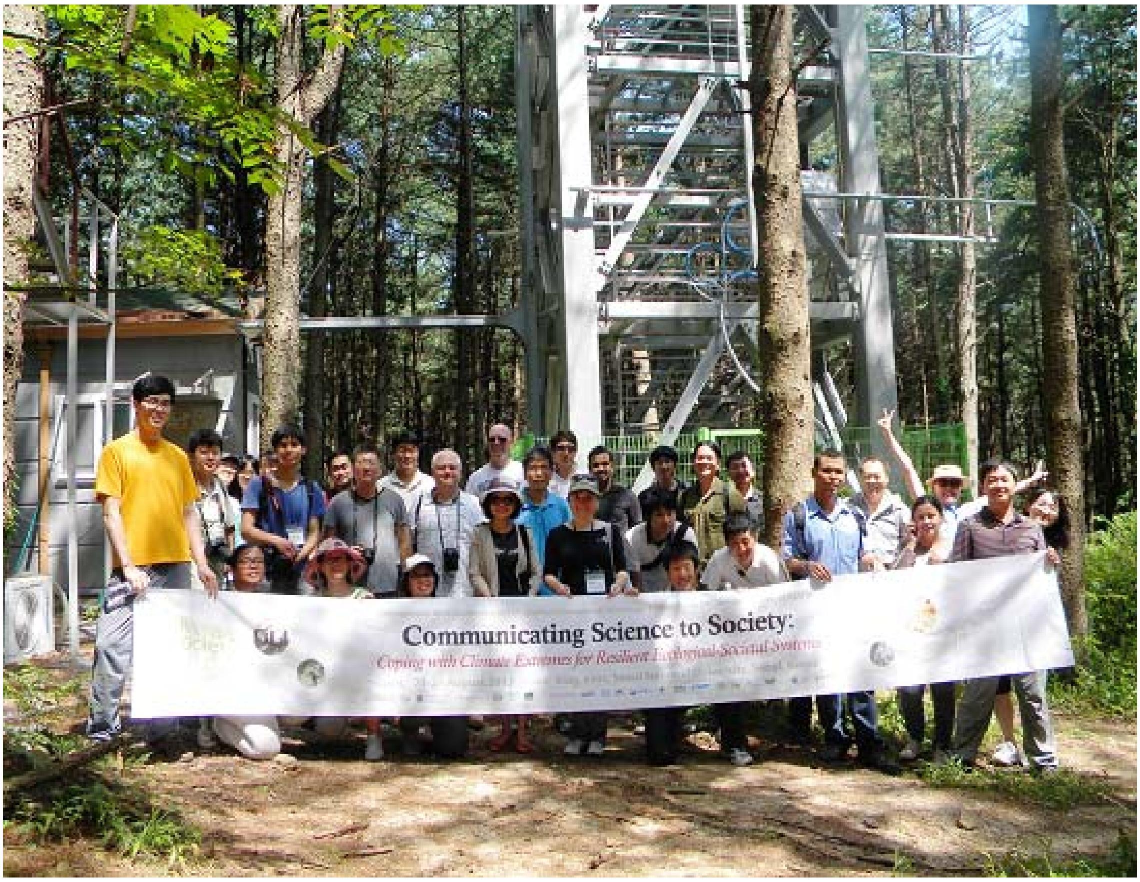

Fig. 4. A group photo of field excursion to Taehwasan University Forest

AsiaFlux Training Course 2012 on Data Analysis for the Eddy Covariance Method

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Tropical forests of Southeast Asia are the world's third largest tropical forests. However, climate change is now affecting this ecosystem. The effect of climate change on tropical forest is of regional and global concern because of the potential feedback to carbon, water and nutrient cycles. Local researchers are still lacking the understanding and guidance to effectively interpret the findings from their experimental site.

During the AsiaFlux Workshop that was held in Johor Bahru, Malaysia in 2011, it was observed that there was a notable growing pool of young researchers from Southeast Asia who had limited access to develop themselves in this field. It was observed that there was a need to do capacity building program for these researchers to develop their understanding and knowledge in eddy covariance (EC) method. A proposal was then put up to have a short training in Sarawak, Malaysia for young researchers and graduate students who have basic knowledge of tower-based EC measurements but are still in need of more training for data analysis, interpretation, and paper writings.

As a result, AsiaFlux short training seminar on data analysis for eddy covariance method was held on 19-21 December 2012 at the Tropical Peat Research Laboratory Unit (TPRL), Sarawak, Malaysia. Fourteen participants from four countries Malaysia (TPPL and Malaysian Oil Palm Board), Singapore (SMART Research Institute), Indonesia (SMART) and Taiwan (Taiwan National Central University) attended the three-day training. The objective of the training was to help young researchers and graduate students to analyze data acquired in their long-term flux monitoring sites particularly in Southeast Asia.

Fig. 1. A group photo of training course participants

The training was mainly divided into three parts i.e. lectures, practicals and presentations. Several lectures were conducted by leading scientists from Japan. Topics that were covered included the overview of flux observation and its importance in Southeast Asian regions, flux calculation theory, CO_2 flux and gapfilling, heat flux, Penman-Montieth conductance, data analysis and writing. During the practicals, the participants were given the opportunity to do flux calculations, and gap filling using datasets and software provided by the lecturers. And finally, all participants were required to do a 15-minute presentation about their respective research work. This session was indeed fruitful for them as they were given valuable scientific advices from the senior scientists and prompted discussions with everyone present.

This training had greatly improved the knowledge and understanding of the participants on how to go further with their research work. Furthermore, trainings such as this had also managed to foster better cooperation between research institutions in Asia.

Acknowledgement

We would like to give our utmost gratitude to the local organizing committee for their support. They comprised of: Prof. Takashi Hirano, (Hokkaido University, Japan), Dr. Nobuko Saigusa (National Institute for Environmental Studies, Japan), Prof. Abdul Latif Ibrahim (Universiti Teknologi Malaysia), Dr. Ryuichi Hirata (National Institute for Environmental Studies, Japan) and Dr. Masahito Ueyama (Osaka Prefecture University, Japan).

Fig. 2. During the seminar

Report of the International ZOTTO workshop

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Background

Northern Eurasia with its large amounts of carbon stored in the forests and soils, as well as in wetlands and the underlying permafrost, represents a hot spot in the Earth System. While climate warming may lead to an expansion of the growing season and thus to more carbon uptake by photosynthesis, concurrent increases in soil respiration will also accelerate carbon dioxide releases, and it is not clear which of these effects will dominate the overall net carbon balance. Warming may liberate a fraction of the carbon stored in wetlands and permafrost either as carbon dioxide (CO_2) or as methane (CH_4). Changes in the hydrological regimes also affect the wildfire frequency and wetland extent. Furthermore, the frequent wildfires in the boreal zone critically affect local air quality and aerosol content, with subsequent effects on tropospheric radiation balance, cloud formation and precipitation patterns. Besides climate, human activities increasingly impact this ecosystem, mostly through logging and modification of forest fire frequency.

In contrast to its global relevance, Siberia is still poorly represented in atmospheric observation systems. In order to monitor regional biogeochemical and climate changes in central Siberia, the Zotino Tall Tower Observatory (ZOTTO, located at 60°48'N, 89°21'E, Fig. 1, http://www.zottoproject.org) was established in 2003 as a cooperation project between the German Max-Planck-Society, primarily the Max Planck Institute for Biogeochemistry, Jena (http://www.bgc-jena.mpg.de) and the V.N. Sukachev Institute of Forest, Krasnoyarsk as a partner project of the International Science and Technology Centre (ISTC, http://www.istc.ru). It is embedded in the Northern Eurasian Earth System Partnership Initiative (NEESPI, http://www.neespi.org), an external project of the International Geosphere-Biosphere Program (IGBP). Within Germany, ZOTTO is supported by the Max Planck Institute for Biogeochemistry in Jena, the Max Planck Institute for Chemistry in Mainz, and the Leibniz Institute for Tropospheric Research in Leipzig.

The ZOTTO 10-years anniversary workshop was held in the V.N. Sukachev Institute of Forest, Krasnoyarsk, Russia, September 16-22, 2013. Over 30 scientists from Germany, Russia, Korea, France, and the Czech Republic discussed the current status and future direction of Siberian climate research. The main objective of workshop was to foster collaboration and networking in order to increase the scientific output of ongoing projects and prepare the way for future projects in the boreal and arctic region. During the two-day workshop, the topics related to the aerosol measurement and modeling, terrestrial ecosystems of northern Eurasia and biogeochemical cycles, impacts of forest fire on boreal forest were discussed.

Monitoring and modeling of aerosol and greenhouse gases

In an opening overview talk, Martin Heimann (MPI-BGC, Jena, Germany) reviewed the ZOTTO project and its scientific rationale. Regional budgets of CO_2 and CH_4 can be estimated from flask and continuous atmospheric mixing ratio data using a nested global-regional three-dimensional atmospheric modeling system (the global "Jena CO_2 Inversion" coupled to the regional Lagrangian STILT model). Evgeny F. Mikhailov (SPbSU, St.Petersburg, Russia) introduced the first results of water uptake measurements by size-selected aerosols at the Zotino tall tower during a summer campaign in 2013. Seungun Lee (SNU, Seoul, Korea) presented the evaluation of GEOS-Chem 3-D global chemical transport model with CO and aerosol data (e.g., particle light absorption, and aerosol size distribution) measured at the Zotino tall tower site during 2006-2010. Meinrat O. Andreae (MPI-C, Mainz, Germany) showed that anthropogenic sources dominate the aerosol population at ZOTTO most of the time, even during nominally clean periods in winter, and that near pristine conditions are encountered only episodically during the growing season. In the afternoon session, Andrey Skorokhod (IAP-RAS, Moscow, Russia) presented main results of atmospheric reactive gases observations at ZOTTO in 2007-2013 and Natalia Pankratova (IAP-RAS, Moscow, Russia) showed zone and

Fig.1. Location of ZOTTO. The map shows as satellite-derived albedo composite (summer) of Central Siberia with the tower location near the Zotino village close to the Yenissei river.

nitric oxides observations in the surface air over northern Eurasia obtained from the Trans Siberian Railway mobile laboratory (TROICA experiment). Antoine Berchet (LSCE, Gif-sur-Yvette, France) presented one year of atmospheric inversion of natural and anthropogenic methane fluxes at the mesoscale over Eurasia in 2010 using a coupled chemistry-transport model (CHIMERE) in a Bayesian framework. Milan Vana (CzechGlobe Centre, Brno, and CHMI, Košetice, Czech Republic) introduced the measurements of greenhouse gas fluxes and atmospheric transport in the Czech Republic, and Jošt Lavrič (MPI-BGC, Jena, Germany) presented the climatology of biogeochemical gas concentrations and their isotopic composition from the flask-sampling program at ZOTTO.

Biogeochemical cycle in the terrestrial ecosystem

In a third oral session several studies related to CO_2 and CH_4 measurement at ecosystem levels were presented: by Olga Shibistova (SIF SB RAS, Krasnoyarsk, Russia)on "Soil CO_2 efflux under contrasting climate patterns: spatial variability and seasonal dynamics", by Evgeniya Golovatskaya (IMCES SB RAS, Tomsk, Russia) on "Diurnal cycles of CO_2 emission from oligotrophic peatland", by Elena Veretennikova (IMCES SB RAS, Tomsk, Russia)on "Methane emissions from natural peatland in West Siberia", and by Anatoly Prokushkin (SIF SB RAS, Krasnoyarsk, Russia) on "Sources, species and fluxes of carbon in rivers of central Siberia".

Topics presented in the poster session included "Carbon stocks in coarse woody debris in the middle taiga" by Alexander Klimchenko (SIF SB RAS, Krasnoyarsk, Russia), "Forest harvest as an underestimated factor driving C dynamics in the ZOTTO footprint area" by Alexey Panov (SIF SB RAS, Krasnoyarsk, Russia), "Determination of the inventory and the composition of the forest floor of boreal forests of the middle taiga" by Ivan Solnyshkin (SibFU, Krasnoyarsk, Russia), and "Preliminary results from CO_2 fluxes measured by the eddy covariance technique in a boreal forest and wetland bog near the Zotino tall tower site" by Sung-Bin Park (MPI-BGC, Jena, Germany). Additional contributions addressed regional and longer time scale topics: "Interannual variability of the $CO_2/H_2O/CH_4$ mixing ratio from the ZOTTO tall tower" by Sung-Bin Park, "Variability of radial growth and carbon isotope composition in tree rings of main boreal species" by Bryukhanova Marina (SIF SB RAS, Krasnoyarsk, Russia), and "comparisons of 25 m inventory GSV maps and forest inventory data" by Mikhail Korets (SIF SB RAS, Krasnoyarsk, Russia).

Impacts on forest fire on boreal ecosystem

Several contributions focused on the role of forest fires: "Post ground fire changes in tree-ring growth, structure and isotope composition in larch in the permafrost zone in Siberia" by Alexander Kirdyanov (SIF SB RAS, Krasnoyarsk, Russia), "Uncertainties of fire emission estimates in Siberia" by Elena Kukavskaya (SIF SB RAS, Krasnoyarsk, Russia), "Space monitoring of wildfire energy release in Siberia" by Eugene Shvetsov (SIF SB RAS, Krasnoyarsk, Russia), "Radiative power of wildfires in Siberia according to FRP calculations by using TERRA/MODIS data" by Evgeni Ponomarev (SIF SB RAS, Krasnoyarsk, Russia), and "Instrumental methods as a tool to predict the threat of optical atmospheric visibility reduction due to large-scale wildfire emissions" by Alexander V. Bryukhanov (SIF SB RAS, Krasnoyarsk, Russia).

Field Excursion to the Zotino Tall Tower Observatory site

On early morning of 20. September at 2:00, the workshop participants left Krasnoyarsk on board a bus. After about 5.30 hours we arrived in Yeniseisk, from where we took a speedboat down the Yenissei river. We reached to Zotino village around 18:00 and ZOTTO after an additional 1-hour ride with a truck.

The 304 m tall tower observation mast is located in the centre of the Siberian Taiga, about 20km west of the Yenisei river at 114 m a.s.l. and about 600 km north of Krasnoyarsk (Fig.2.). The tall tower station includes instrumentation for continuous high-precision monitoring of carbon dioxide, methane, carbon monoxide in the surface and planetary boundary layer. Mixing ratios of CO_2, H_2O, and CH_4 are measured with a cavity ring-down spectroscopy analyzer from six heights up to 301 m a.g.l. (Winderlich et al, 2010). Additional measurement systems monitor aerosols and reactive chemistry (currently ozone and NOx), as well as the local meteorology. Since 2007, meteorological variables together with vertical and horizontal soil parameters are also determined at two locations about 100 m southeast from the tower. Both places are sandy soils covered by lichens. Air samples taken in pressurized 1-l glass flasks (1.6 bar) from the 300 m tower level are routinely taken weekly or bi-weekly in triplicates for quality control and for laboratory analyses of the concentrations of CO_2, CO, CH_4, N_2O, H_2, the stable isotope ratio

Fig. 2. Aerial view of the ZOTTO tall tower.

Fig. 3. Eddy Covariance flux towers in boreal forest (left, 30 m) and bog (right, 10 m) at ZOTTO site.

$^{13}C/^{12}C$ and $^{18}O/^{16}O$ in CO_2 and the O_2/N_2 and Ar/N_2 molecular ratio. Since 2010, also the stable isotope ratios of $^{13}C/^{12}C$ and D/H in CH_4 are determined on selected flask samples.

Since June 2012, north and north-east from the tall tower, two eddy covariance systems have been installed in the forest and in a bog in order to monitor in situ the exchange fluxes of CO_2, H_2O, and CH_4 (Fig. 3). The ecosystem in the light taiga around the station comprises Pinus sylvestris forest stands (about 20 m height) on lichen covered sandy soils. The ombrotrophic bog is surrounded by monotypic stands of Pinus sylvestris (Schulze et al, 2002).

Outlook

It is essential to distinguish between short-term diurnal, synoptic, seasonal, interannual land multi-decadal natural climate variability. Especially the detection of long-term trends requires sustained monitoring systems in order to provide statistically significant observations. Such trends are important to determine since many of critical processes such as vegetation shifts or permafrost melting are occurring relatively slowly over decades. Furthermore, long-term measurements also provide the indispensable baseline against which the response of boreal ecosystems to extreme events can be detected. For example the exceptionally dry and hot summer accompanied by extensive fires of the year 2010 could be captured in some of the measurements at ZOTTO.

ZOTTO is intended to serve the scientific community for 30 years or more as one of the world's major continental observatories. It is planned that ZOTTO will become a certified station of the Global Atmosphere Watch network of the World Meteorological Organization. It will document and help quantify the natural and anthropogenic changes in biogeochemical cycles in the boreal and arctic Eurasia occurring during the next decades.

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Sap flow measurements for understanding physiological processes within a tree

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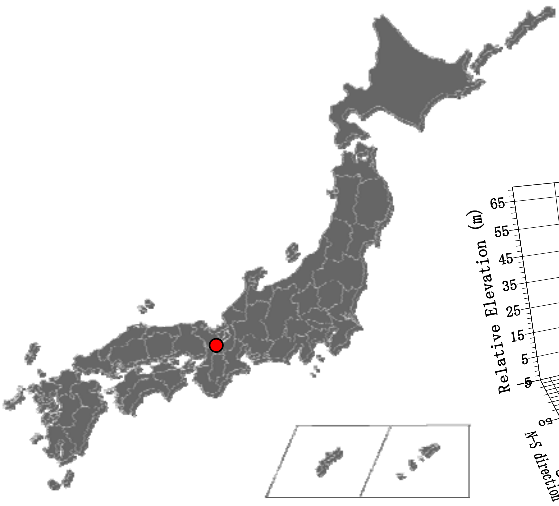
1. Introduction

To understand the mechanism of changes in CO_2 and H_2O exchange over a forest canopy, recent studies have examined the relationship between leaf-level photosynthesis / transpiration measurements and stand-level CO_2 and H_2O exchange measurements. Leaf-level physiological measurements can reveal the process of changes in CO_2 and H_2O exchange rates according to environmental changes. Tree-level physiological measurements have an intermediate role in scaling-up from leaf-level measurements to canopy-level CO_2 and H_2O exchange. Sap flow measurements, which clarify tree-level water use, are useful for examining the relationship between leaf-level H_2O exchange and stand-level H_2O exchange. Canopy-level stomatal conductance was calculated from canopy-level transpiration rates estimated by sap flow measurements (e.g. Oren et al. 2001; Kumagai et al. 2005; Iida et al. 2013). In those studies, sap flow rates were used for comparing the changes in canopy-level stomatal conductance with the seasonal changes in vapor pressure deficit. On the other hand, sap flow rates also show diurnal and daily changes depending on instantaneous changes in environmental conditions as a physiological approach. In this study, we report the factors that cause diurnal and daily changes in sap flow rates and discuss the use of tree-level physiological measurements for understanding the dynamics of forest ecosystems.

2. Study Site

This study was conducted at the Yamashiro Experimental Forest (N 34º 47′, E 135º 50′) located in central Japan (Fig. 1). The annual mean air temperature is 15.5ºC and annual precipitation is 1,449 mm. The total aboveground biomass in this forest was 126 t ha^{-1} in 2009, and 67% of the biomass was occupied by deciduous broad-leaved trees including *Quercus serrata* and 28% by evergreen broad-leaved trees. NEE has been measured using two meteorological towers since 2000 (Fig. 2; Kominami et al. 2003). As well as meteorological measurements, CO_2 exchange rates from leaves, branches, roots and CWD have been measured by the chamber method (Dannoura et al. 2006; Jomura et al. 2007; Miyama et al. 2003). By combining CO_2 exchange rates by the eddy covariance and chamber methods, it is possible to relate the carbon exchange over the canopy with each specific process of CO_2 exchange in the forest (Kominami et al. 2008). Recently, we tried to express tree-level physiology by examining the relationship carbon and water use among each



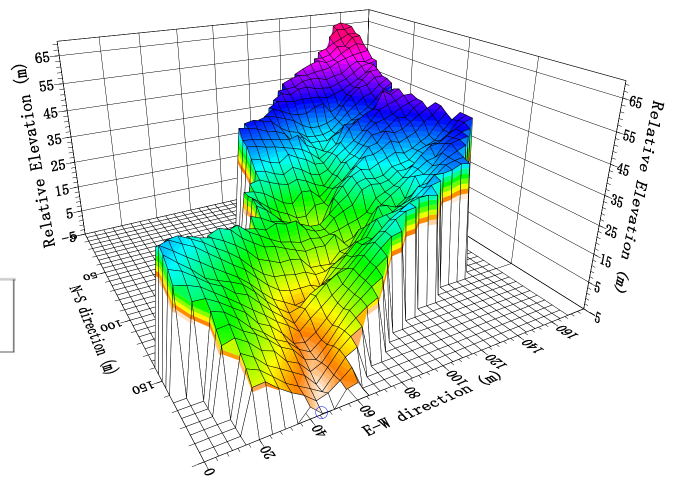


Fig. 1. The Yamashiro Experimental Forest is located in central Japan (left) and has complex terrain (right).

Fig. 2. Twin flux towers in the Yamashiro Experimental Forest.

organ (i.e. leaves, stem, roots) by measuring CO_2 exchange rates and sap flow rates.

3. Measurement of Sap Flow Rates

Various methods using heat probes have been proposed for measuring sap flow rates, and are based on the phenomenon that the heat emitted by a probe inside a stem diffuses asymmetrically with sap flow (Smith and Allen 1996). The heat dissipation method (HDM; Granier 1985), in which the temperature around a heater probe is higher at night than at noon because the heat of the probe is removed by heat dissipation according to sap flow, was used in this study (Fig. 3).

Sap flow rates increased in the morning and decreased in the evening and depended on the vapor pressure deficit and stomatal conductance. Photosynthetic rates of leaves and sap flow rates increased simultaneously in the morning, but photosynthetic rates decreased before the sap flow showed the maximum rates (Fig. 4). Stomatal closure causes this pattern in photosynthetic rates and decelerates the increase in sap flow rates. Under daily measurements, sap flow rates increased after rainfall events and decreased in the soil drying process (Fig. 5). This pattern depends on the pattern of soil water content, which increases after rainfall events and then gradually decreases. In this way, both atmospheric and soil water conditions affect diurnal and daily changes in the water use of tree stems.

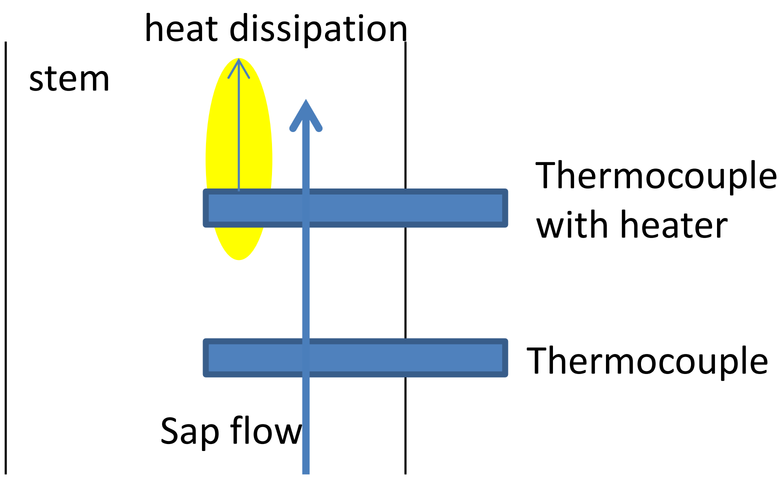


Fig. 3. Schematic design of measuring sap flow rates with HDM.

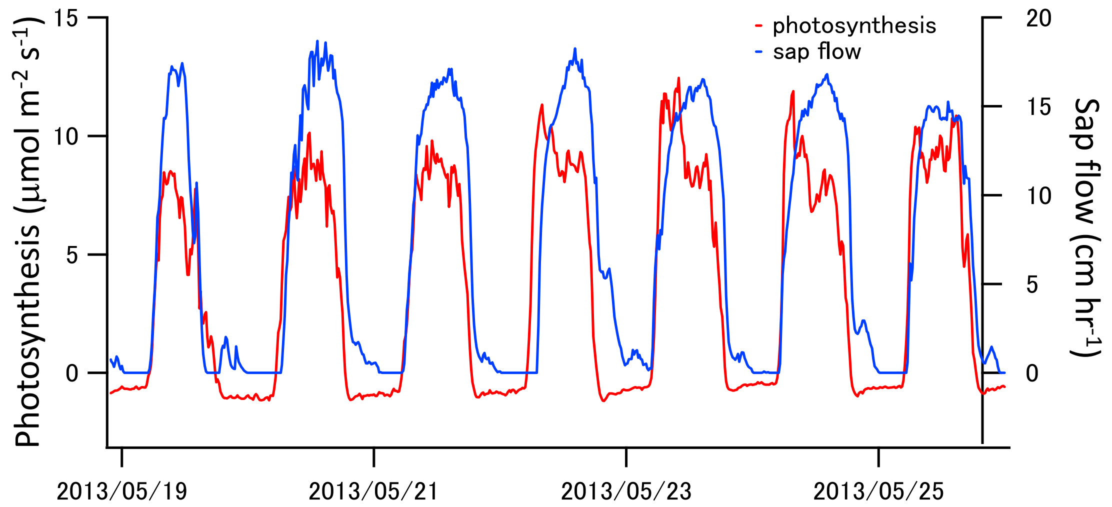


Fig. 4. Diurnal and daily changes in sap flow rates and photosynthetic rates of *Quercus serrata*. Photosynthetic rates were continuously measured by an automated chamber system.

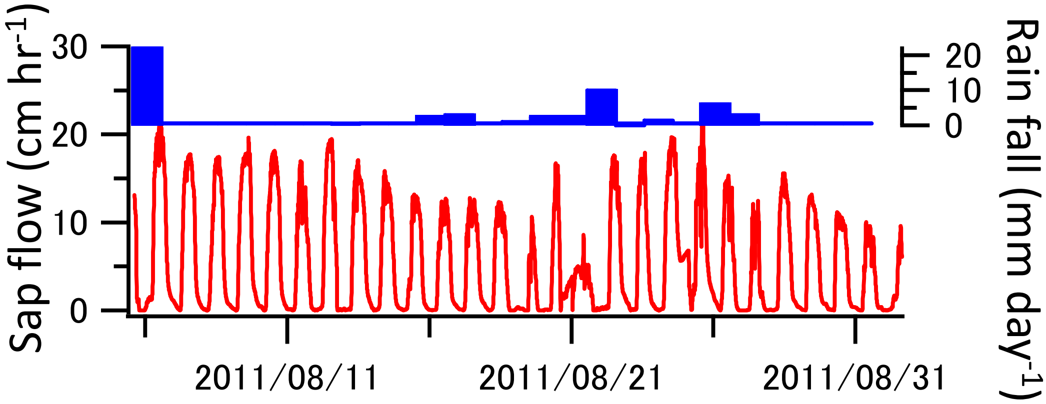


Fig. 5. Daily changes in sap flow rates of *Quercus serrata* after rainfall events.

4. Sap Flow Measurement as an Indicator of Forest Dynamics

Sap flow measurements can be adapted to studies of forest ecology as well as plant physiology. Recently in Japan, there has been extensive tree death in some Fagaceae species caused by fungus (*Raffaelea quercivora*) invasion carried by bark beetles (*Platypus quercivorus);* this is called Japanese oak wilt (Hulcr and Dunn 2011). Large areas of Japanese forests are dominated by invasible Fagaceae species such as Quercus and Castanopsis, thus this disease can massively disturb forest dynamics (Fig. 6). Trees die after the stop of sap flow because fungus invasion indirectly results in xylem embolism. Therefore, measurements of sap flow rates will yield information on the extent of damage from the disease.

Japanese oak wilt started to damage deciduous oak trees (*Q. serrata*) also in the Yamashiro Experimental Forest in the summer of 2013. The changes in sap flow rates in attacked trees may be regarded as an indicator of their health, meaning not only water use but also whole-tree photosynthetic rates. A comparison of changes in NEE measured by tower and sap flow rates can reveal the contribution of wilt disease in each tree to forest level carbon exchange.

The impacts of large-scale disturbances or extreme events on a forest ecosystem come to be assessed in flux studies, as discussed in presentations at the AsiaFlux Workshop. Some of these studies assessed the reduction of carbon sequestration by disturbance impacts and the resilience of carbon sequestration after disturbance. The responses of tree physiology due to changes in environment (i.e. increased light intensity on the forest floor after a disturbance) contribute to the resilience of forest-level carbon sequestration. Whole-tree physiological measurements such as those of sap flow rates are an important tool for revealing the mechanism of forest-level resilience.

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Fig. 6. A forest stand before (left) and after (right) damage by Japanese oak wilt disease. The lack of canopy trees causes an abundance of understory grass, and the appearance of the forest drastically changes. Disturbance is an important factor when considering forest ecology and forest carbon sequestration.

Establishment of eddy-flux site in Vietnam: first results

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1. Introduction

Vietnam is a rapidly developing country of South-East Asia. Vietnam has a wide range of natural ecosystems, most of them changed in different extent by human activity. Vietnamese forests have total of more than 7,000 plant species, including more then 3,000 trees. Before the Second Indochina War forests covered about 47 % of the territory. During the war (ending of 1950th-1975) forests have suffered from defoliants, and after the war from developing of agriculture. According to the FAO, in the late 1970s deforestation rate run up to 1,730 km2 per year (about 2 %), and in 1981 - 650 km2 (0.7 %) (FAO, 1988). By 1995 forest ecosystems occupied 28 % of the country. So, the urgent conservation measures were undertaken, namely the creation of a network of protected forest areas (national parks and nature reserves). Scientists of the Russian-Vietnamese Tropical Center had being started comprehensive studies of Vietnamese tropical ecosystems more than 20 years ago (Structure.., 2011). Long-term study of functioning and dynamics of tropical monsoon forests on the territory of Southern Vietnam prepared the base for the creation of the first Eddy -flux site in Nam Cat Tien (NCT) National Park (http://www.namcattien.org).

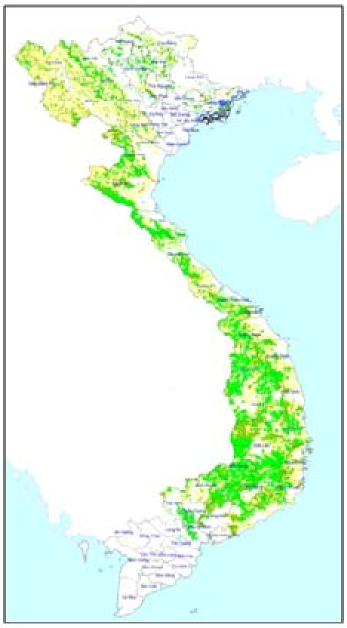
2. Site description

Nam Cat Tien is a part of a larger Cat Tien national park in Southern Vietnam which has a status of UNESCO biosphere reserve. NCT is located partly in 3 provinces: Dong Nai, Binh Phuoc and Lam Dong. Southern Vietnam has plain terrain which passes on north-east into foothills of Central Highlands of Vietnam (Fig. 2). True altitude of the site and surroundings is 130-150 m. Measurement site location is N11° 26´30.5´´, E107°24´4.6´´. It is surrounded by relatively flat and homogeneous terrain and so forest cover (Fig. 3). East and north parts of the Park are bordered with Dong Nai river which has the second size in Southern Vietnam after Mekong River. Rocks are basalt tuff and schist (the area was a volcanic crater in the late Pleistocene). Soils are dystric cambisols with relatively high fertility and have a small depth of one to few meters before reaching the compact natural rock.

Climate is tropical monsoon with dry season in winter and wet (rainy) season in summer. Annual temperature (T) according to nearby meteorological station Dong Xoai (1981–2010 means) is 26.4ºC, whereas the coolest month is December with mean 24.7ºC and the hottest one is Apr with 28.3ºC (the first part and the end of dry season correspondingly). The fixed absolute minimum T was 13.0ºC in Dec-Jan and the fixed absolute maximum T was 38.5ºC in Apr. Average year precipitation rate is 2518 mm year^{-1}.

Four months of a year (from Dec to Mar) have precipitation rates low then 100 mm month^{-1} while Sep, the wettest month, has total of 442.2 mm month^{-1}. Such high precipitation rate along with over-wetted soil and close-to-surface basalt rock cause flooding of big areas in the national park, lakes and rivers repletion as well as numerous puddles formation in each minor relief depression. I.e., soil water regime has three modes: first one is no water penetrating in deeper than 10 cm layers (dry season), second one is water percolation through the soil (first part of rainy season and transition from wet to dry season) and last one is water stagnation (the peak of rainy season).

The object of investigation is primary, but disturbed semi-evergreen tropical seasonal forest with complex structure (3-5 layers) and canopy height of about 37 m. The main species are Lagerstroemia calyculata (Lythraceae), Haldina cordifolia (Rubiaceae), Tetrameles nudiflora (Datiscaceae), Afzelia xylocarpa



Shrubs with scattered trees
Plantations
Natural forests, high rate of reserves
Natural forests, low rate of reserves
Shrubs

Fig. 1. Forest cover of Vietnam

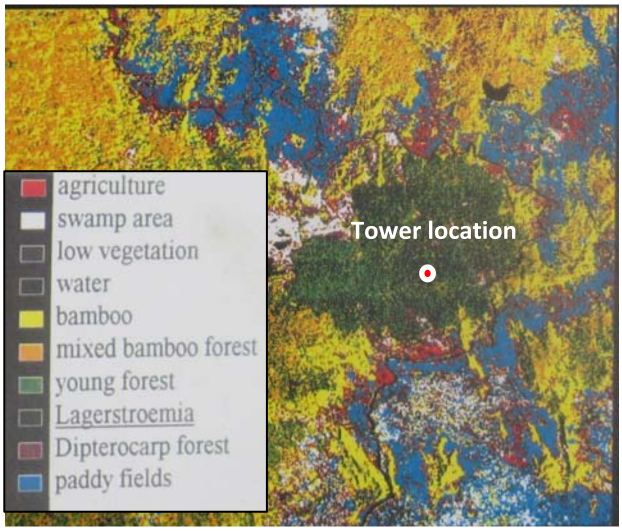


Fig. 3. Nam Cat Tien flux tower location in the national park

Fig. 4. Nam Cat Tien flux tower

Fig. 5. Eddy Covariance sensors at Nam Cat Tien flux tower: LI-7500A and CSAT3

Fig. 2. Nam Cat Tien flux tower location in Southern Vietnam

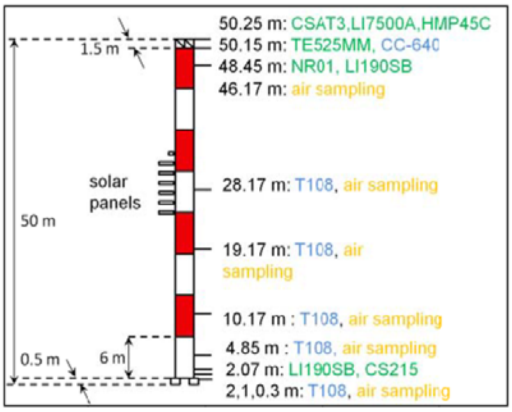


Fig. 6. Scheme of sensors heights at Nam Cat Tien flux

(Caesalpiniaceae), Sterculia cf. cochinchinensis (Sterculiaceae) at elevated parcel and Dipterocar pus alatus, Hopea odorata (Dipterocarpaceae), Hydnocarpus cf. anthelmintica (Kiggelariaceae) at seasonal flooded parcels (Structure.., 2011). All trees of first canopy layer and a part of trees of 2nd layer lose their leaves in Dec-Feb. Continuous litter cover remain at soil surface to the first part of wet season when microbial activity rises with increasing water availability.

Table 1. List of sensors at Nam Cat Tien flux tower

1. Eddy Covariance

№	Type of sensor	Location	Measurements
	CSAT3 (Campbell Scientific, USA) 3D ultrasonic anemometer	50 m	3-dimensional components of wind speed
	LI7500A (Li-Cor, USA) Open-path gas analyzer	50 m	CO_2 and water vapor concentrations in air, atmospheric pressure
	HMP45C (Vaisala, Finland) Thermometer-hygrometer	50 m	Air temperature and humidity
	LI190SB (Li-Cor, USA). Quantum sensor (PAR)	50 m, 2m	Photosynthetically active radiation
	NR01 (Hukseflux, Netherlands) 4-component radiometer	50 m	Upward and downward short-wave and long-wave radiation
	TE525MM (Texas Electronics, USA) Rain gauge	50 m	Precipitation rate
	TCAV-L (Campbell Scientific, USA) Temperature average, 2 items	In soil, at a depth of 5 cm	Soil temperature
	CS616 (Campbell Scientific, USA) Moisture content reflectometer, 2 items	In soil, at a depth of 5 cm	Soil volumetric moisture content
	HFP01 (Hukseflux, Netherlands) Heat flux plate, 4 items	In soil, at a depth of 8 cm	Heat flux into/from soil

2. Temperature profile system

№	Type of sensor	Location	Measurements
	T108 (Campbell Scientific, USA) Temperature sensor, 7 items	28.17, 19.17, 10.17, 4.85, 2, 1, 0.3 m	Air temperature
	T108 (Campbell Scientific, USA) Temperature sensor, 12 items	In soil, at a depth of 5, 20, 30, 50 cm (3 items at each depth)	Soil temperature
	CS616 (Campbell Scientific, USA) Moisture content reflectometer, 12 items	In soil, at a depth of 5, 20, 30, 50 cm (3 items at each depth)	Soil volumetric moisture content
	257L (Campbell Scientific, USA) Soil matric potential block, 3 items	In soil, at a depth of 5 cm	Soil water potential
	HFP01 (Hukseflux, Netherlands) Heat flux plate, 3 items	In soil, at a depth of 8 cm	Heat flux into/from soil
	CC640 (Campbell Scientific, USA) Digital camera	49 m	Canopy state observations

3. CO_2 profile system

№	Type of sensor	Location	Measurements
	Profile intake, 8 items (Campbell Scientific, USA)+LI820 (Li-Cor, USA) Close-path gas analyzer	46.17, 28.17, 19.17, 10.17, 4.85, 2, 1, 0.3 m above ground	Air CO_2 concentration

3.Site measurements and data processing- The beginning of measurements in NCT belongs to November 2011. Three systems of sensors work independently at the 50-m scaffold tower (Fig. 4 - 6): 10 Hz open-path eddy covariance 30 min air&soil temperature and moisture profile, 30 min CO_2 concentration profile. Main sensors and measurement types are listed in Table 1. In addition to eddy covariance, meteorological and soil regime measurements, some additional data are collected, including soil respiration, litterfall, interception of precipitation, soil water percolation. Also canopy photographs are taken for phonology cycle tracking. Fluxes were calculated using EddyPro software (LI-COR inc., USA), storage term also incorporated and then fluxes were subjected to gap-filling and flux partitioning by means of Max-Plank Institute (Germany)

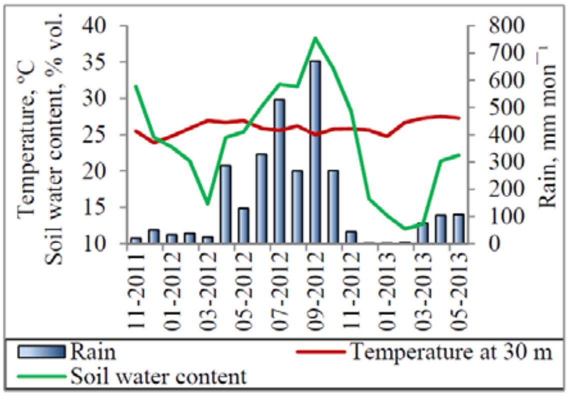


Fig. 7. Preicpitation rate, temperature and volumetric soil water content at NCT site

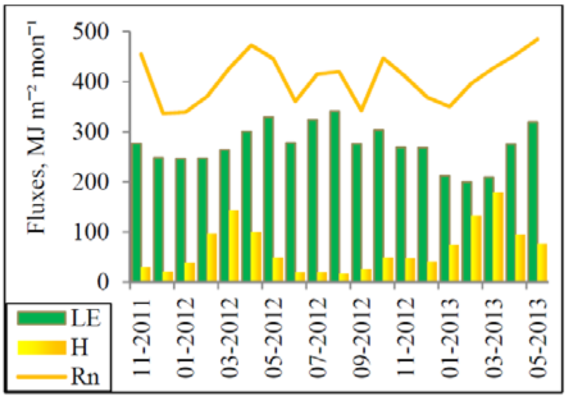


Fig. 8. Radiation balance (Rn), latent heat flux (LE) and sensible heat flux (H) at NCT site

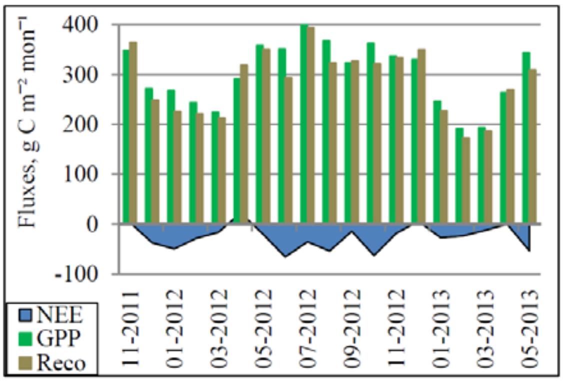


Fig. 9. Net ecosystem exchange (NEE), gross primary production (GPP) and ecosystem respiration (Reco) at NCT site

Online Eddy Covariance gap-filling and flux-partitioning tool. Gap-filling and flux-partitioning were made according to (Reichstein et al., 2005). Each step of processing included despiking; spikes occurred when people were at the tower, during most of rains, in too high turbulence (u*>10 m $^{s-1}$), in some strange cases (may be insects or birds influence on sensors). For all fluxes we used u*-threshold of 0.176 m $^{s-1}$; this threshold was determined by means of FluxAnalysisTool (Masahito Ueyama, Japan). About 63% of net ecosystem exchange (NEE) data remain after excluding bad flags, spikes, periods of sensors repair and calibration; but after excluding data under low turbulence only 37% of them were still present.

4. Results and discussion

The dynamic of latent heat flux (LE) generally follows the dynamic of radiation balance (Rn), while sensible heat flux (H) shows drastic increase in the end of dry season with both lack of moisture and intensive radiation (Fig. 7 and Fig. 8). Bowen ratio (H/LE) reaches 0.5-0.8 in these periods, while in rainy season H comes to only 0.05-0.08 of LE.

GPP and ecosystem respiration (Reco) are strongly seasonality with reduction of both photosynthesis and respiration in dry season (Fig. 9). In 2012 the forest was strong carbon sink of ‑337 g C m^{-2} $year^{-1}$, which is not typical for tropical forests. Carbon balance of the monsoon tropical forest was negative during wet season and the middle of dry season while near-to-zero or positive in the beginning and the end of dry season. Such a dynamic may be probably explained by the following: mainly uptake of CO_2 throughout the period of measurements may be caused by forest recovery from recent anthropogenic disturbance (the national park obtained a reserve status only in 2001; before the forest was undergoing selective cuttings). Also the climate change may be the reason of forest carbon pool changes, because for the last 30 years temperature of the coolest month has grown by 2.3‑2.4°C (standard deviation = 0.9 °C) and precipitation rates of dry season slightly increased too.

5. Conclusions

Main carbon conclusions at Nam Cat Tien EC site in seasonal tropical forest are:

1. The monsoonal forest was a strong carbon sink of -337 g C $m\text{-}^2$ $year\text{-}^1$ during 2012. It is not typical for tropical forests so the possible reason for carbon deposition may be recovery from past disturbance or climate change.

2. Gross primary production and ecosystem respiration had a magnitude of 300-400 g C m^{-2} $month\text{-}^1$ in rainy season as usual for wet tropical forests, but decrease by 1/3 both for GPP and Reco in dry season when upper layer trees shed their leaves.

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The Editor of AsiaFlux
Newsletter No. 36
Takafumi Miyama
(Forestry and Forest Products
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First of all, I would like to express my condolences for the people who lost lives in the disasters and offer my heartfelt sympathy for those affected by the disasters due to typhoon in Philippine. I hope our research network can contribute to the mitigation of the climate change in the future.

This newsletter was aimed to report the general summary of 11th AsiaFlux Workshop as the joint conference in Korea, AsiaFlux Training Course 2012 in Malaysia, International ZOTTO 10-years anniversary workshop in Russia and to introduce flux sites in Vietnam (Nam Cat Tien) and Japan (Yamashiro). I am pleased to share these fruitful activities and site information in AsiaFlux. This newsletter was supported by time and effort of authors and secretariat of AsiaFlux. I am sincerely thankful to Dr. Melling, Dr. Kang, Dr. Kurbatova, Dr. Yoshimura, Dr. Park, Dr. Tanaka and all coauthors for their contributions to this issue.

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