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Contents

Thinking Community, Learning Frontiers

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Chair & Vice-chairs of AsiaFlux

"Family, friends, community - these are the sources of greatest joy and love we experience as humans. We visit family members, keep in touch with favorite teachers, share and exchange pleasantries with friends. We undertake *difficult projects to help others, save frogs or protect a wilderness, and in the process discover extreme satisfaction. We find spiritual fulfillment in nature or by helping others. None of these pleasure requires to consume things from the Earth, yet each is deeply fulfilling. These are* complex pleasures, and they bring us much closer to real happiness than the simple ones, like *a bottle of Coke or a new minivan."*

- David Suzuki -

As this new century unfolds, two developments (which are currently on a collision course) will have major impacts on our well-being and ways of life: (1) the rise of global capitalism and (2) the creation of sustainable communities based on biosphere consciousness.[1] Interestingly, both have to do with 'networks' and involve 'innovative technologies.' Global capitalism, with the goal to maximize the wealth and power of its elites, is concerned with electronic networks of financial and informational flows. Sustainability through biosphere consciousness, on the other hand, is concerned with ecological networks of energy and material flows (which are what we monitor in AsiaFlux!) with the goal to maximize the sustainability of the web of life.[2]

We humans have worked such vast and unprecedented changes to our planet, which have ushered in a new geological time interval – the *Anthropocene* epoch. We now face the bittersweet prospect of approaching *global empathy* in a highly energy-intensive, interconnected social-ecological systems, riding on the back of an escalating entropic juggernaut that threatens catastrophic climate change and our very existence[1]. Resolving this 'empathy/entropy paradox' (e.g., increasing biosphere consciousness while decreasing material consumption) is the critical test of 'sustainability' – the possibility and the destiny that human and nature will flourish together on Earth in the future. We are challenged to rethink and reposition ourselves with the most important question: *Can we reach such profound change of values as biosphere consciousness and* *global empathy in time to stop and reverse the present depletion of natural resources, extinction of species, pollution, and global climate change?*

Biosphere consciousness (e.g., ecoliteracy) based on ecosystem science, service and stewardship requires systems thinking - thinking in terms of relationships, context, patterns, processes, and purposes. It requires a dramatic paradigm shift from 'object' to 'relationship.' Ecology in a nutshell is networks, which is the science of relationships among the members of Earth's household.[2] 'Sustainability through biosphere consciousness' is the core of the AsiaFlux mission, i.e., to bring Asia's key ecosystems under observation to ensure quality and sustainability of life on Earth.[3] Time and again, the 2010 AsiaFlux workshop was a community effort to provide the agora for thinking together and sharing the lessons learned to answer the above overarching question. Our theme was "*New Challenges of FLUXNET Community to Resilient Carbon/Water Management*." Here, we mean 'management' by 'operationalization of vision,' i.e., translating vision into reality/action by developing and implementing strategies leading to transformation in our thinking and ways of life towards sustainability.[4]

Why *resilience-based systems thinking*? Simply put, it captures the dynamic and empathic nature of our world - both social and ecological. It focuses on how the system changes and copes with disturbances, not only anticipating and responding but also creating and shaping them. Successful management and adaptation for social-ecological sustainability requires resilience thinking – communal capacity to respond to environmental feedback, to learn and store understanding, and be prepared and adaptive to allow for change.[5] Building resilience will require the dynamic interplay between diversity and disturbance, along with recognition of cross-scale dependencies. Resilience thinking encourages both scientists and practitioners to work together with the public to produce trustworthy knowledge and judgment that is scientifically sound and socially robust.

We are so thankful to ChinaFlux, particularly the local organizing committee for hosting our 2010 workshop in a vibrant city of Guangzhou in China where the inspiration and the heat for the Asian Games 2010 was still on. The local organizing committee prepared several pillar sessions to address the issues towards resilient regional carbon/water management, including current issues in flux measurement and monitoring; couplings among cycles of carbon, water, and nitrogen; effects of natural and human disturbances on ecosystem assessment; synthesis on regional carbon/water budget; and resilience management based on ecosystem stewardship.

The year 2010 was very fruitful as reflected in our memory and the newsletters. We are so grateful to all the members who have strived to make serious contributions to fulfill our vision and excited to bring in 2011 to press on particularly with new leadership. Time and again, we celebrate our vision, "thinking community, learning frontiers" - the agora for ecosystem science, service and stewardship by producing and practicing knowledge characterized by cross-disciplinarity, contextualization, and cultural diversity. We are making steadfast progress towards two ambitious short-term goals: (1) to publish the first AsiaFlux Synthesis & Assessment report and (2) to establish a solid infrastructure for the Agora for Creative Thinking in Systems (ACTS) toward sustainability.[6]

Remember our 2010 New Year' resolution? (1) Become a better (not just bigger) community, (2) better connected and self-organized, (3) volunteer more to serve others, (4) collaborate more rigorously, (5) reach out to learn and teach, (6) join one of the five Workgroups (i.e., Measurement Standards, Data Management & Policy, Synthesis & Assessment, Short Courses, and ACTS), (7) reprioritize goals and tasks, (8) embrace resilience -based systems thinking, (9) stick to our vision by embracing it individually, and (10) never stop 'flux'ing while networking with one another including the local communities.

Let us press on and not lose heart in doing good, for in due time we will reap if we do not grow weary!

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Report of the AsiaFlux Workshop 2010
New Challenges of Fluxnet Community to Resilient Carbon/Water Management

Zhongmin Hu and AsiaFlux Workshop 2010 Local Organizing Committee

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Following the 16th Asia Games, the 9th AsiaFlux Workshop was held on 1-3 December, 2010 in Guangzhou, China. This workshop provided a great opportunity to scientists in flux research communities to share their latest scientific achievements on issues towards resilient carbon and water management. More than 250 scientists from ca. 20 countries/regions took part in the workshop (Fig. 1). 52 oral and 80 poster presentations were presented in the workshop.

During the past two decades, with the development of regional and global networks of eddy covariance flux measurements, our understanding of the carbon budget for diverse ecosystems has been greatly improved. However, flux measurements are facing new challenges towards the mission of regional carbon management. Therefore, this Workshop discussed the scientific challenges on the current issues in flux measurement and monitoring; couplings among cycles of carbon, water and nitrogen; the effects of natural and human disturbances on ecosystem assessment; a new synthesis on regional carbon budget; as well as resilient carbon/water management and ecosystem stewardship. Five regular oral sessions were organized to address the issues towards resilient regional carbon/water management. And also, one additional session was organized to share the recent progresses in the flux synthesis studies in Asia under the CarboEastAsia program, which has been implemented to support international collaborations among global change scientists particularly from China, Korea and Japan.

Opening Session

AsiaFlux Workshop 2010 was opened on December 1. The opening started with ebullient welcome addresses from Prof. Shenggong Li, the chair of local organizing committee, Prof. Joon Kim the chair of AsiaFlux, Ms Yinglan Zhang, deputy of the sponsors, and Prof. Shenglei Fu, the director of local host institute. Reports from regional Flux Networks were presented consequently. Five representatives from AsiaFlux, JanpanFlux, KoFlux, TaiwanFlux and ChinaFLUX gave wonderful reports about their recent progresses in flux-related activities.

Plenary Session

The plenary session was held in the mornings of 1-3 December. Two keynote speeches were presented in each day. The first-day keynote speeches were given by Prof. Xuhui Lee and Prof. John Tenhunen. Their presentation focused on in-situ measurement of water vapor isotope, and how to use flux measurements to achieve regional resilience and sustainability, respectively. The second-day keynote speakers were Prof. Riccardo Valentini and Dr. Ray Leuning. Prof. Valentini

Fig. 1 Group picture of the participants of AsiaFlux Workshop 2010

discussed the current carbon cycle variability and the different methods and approaches available to quantify the terrestrial ecosystem carbon budget. Dr. Leuning introduced the current progress of the thorny issue of estimating night time ecosystem respiration in his group. In the third-day morning, Prof. Jingming Chen and Dr. Shilong Piao introduced their recent work on estimating regional carbon budget with modeling and multiple sources.

Regular oral sessions

(1) Current Issues in Flux Measurement and Monitoring

There were 9 oral presentations in Session I. This session discussed current problems and their solutions for carbon & water fluxes measurement, share the progresses in the application of stable isotope technique in flux research. In this session, though studies were carried out in different ecosystems and different areas, measured gases can be summed up into CO_2, methane, and several other greenhouse gases, and the methods involved included eddy covariance, stable and radioactive isotopes and other regular methods.

(2) Couplings among Cycles of Carbon, Water, and Nitrogen

10 reports were given around the theme of Session II. This session focused on the direct and indirect interactions between ecosystem carbon, water and nitrogen cycles at different temporal and spatial scales and their consequences on ecosystem structure and function. Scientists from different countries reported their recent progresses in this field. We not only discussed the relationships among carbon, water and nitrogen, but also the effects of some environmental factors on these relationships. Meanwhile, results of modeling nitrogen deposition and N_2O emission were also presented.

(3) Interfaces between Carbon Science and Society: Resilient Carbon & Water Management

Session III was composed of 5 reports. This session focused on recent researches on developing systems to transfer the scientific knowledge to the society, to assess the effects of carbon and water management, and to provide socio-economic resolutions to prevent and mitigate the risk of human-induced climate change associated with carbon, water and energy cycles in Asia. Dr. Yuling Fu gave an exhaustive report on carbon budget and management for eastern Asian grasslands.

(4) Effects of Disturbances on Ecosystem Assessment

Session IV has begun on December 2 afternoon. This session addressed the impacts of natural disturbances (e.g. drought, flood, storm, heavy snow, insect, fire etc), and human activities (e.g. grazing, thinning, deforestation, afforestation, crop rotation, etc.) on ecosystem services. Typical disturbance cases, e.g., the effects of 2008 ice storm in south China on the subtropical forest, were presented in this session. Extreme precipitation, typhoon, drought and land use practices, all of these factors had a strong impact on carbon cycle, evapotranspiration, energy exchanges, and net ecosystem exchange.

(5) CarboEastAsia & HydroEastAsia

CarboEastAsia and HydroEastAsia session is for member scientists to share their recent progresses in synthesis studies of carbon and water fluxes in East Asia. Beginning with Dr. Nobuko Saigusa's report "Resilience of forest ecosystems to disturbances caused by strong winds", Dr. Shaoqiang Wang introduced his work on the effects of climate change and plantation on carbon budget of coniferous forests in Poyang lake basin in China from 1981 to 2008. Dr. Hyojung Kwon introduced her work about evapotranspiration mapping from local to region. Prof. Weimin Ju gave a report focusing on changes in water use efficiency and driving factors of east Asia over the past 25 years.

(6) Regional Carbon Budget: A New Synthesis

On December 3, the last session Regional Carbon Budget: A New Synthesis was held after two keynote speeches by Prof. Jingming Chen and Dr. Shilong Piao. Session VI consisted of 4 presentations and this session aimed to share the

Fig. 2 Enthusiastic communications among the participants of the Young Scientist Meeting

state-of-the-art of methods used in scaling carbon budget from site to regional scale, and to discuss the uncertainties in assessment and synthesis. Dr. Li Zhang gave a talk on behalf of Dr. Honglin He about the progress on the application of cyber-infrastructure for carbon cycle research based on ChinaFLUX, and Dr. Ruiying Chang introduced her project 'grain for green' in Loess Plateau China. Applications of model-data synthesis using biometric and remote sensing techniques used in different ecosystems were also discussed.

Poster Sessions

The poster sessions were held every afternoon after the oral sessions (16:10-18:00), which is about 30 min longer than those in previous AsiaFlux Workshops. The extended poster sessions provided more time for in-depth communication between the authors and the audience. Almost all the participants took part in the oral session. And participants and authors exchanged their ideas and had deep discussions on the issues they were interested in.

Young Scientist Meeting

AsiaFlux 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 held in the night of December 2. Nearly 60 young scientists from China, Japan, Korea, Malaysia, Singapore, Philippine, and India participated in this meeting (Fig. 2). Five outstanding young scientists and guest speakers: Drs. Younghee Lee, Yong Li, Hyojung Kwon, Maricar Aguilos and Masayuki Kondo, shared their experiences in studying abroad and gave many useful tips on how to succeed in overseas. After the reports from the guest speakers, young scientists had more than one hour free talk, which gave all a good opportunity to know each other's research backgrounds. Participants also shared other information such as culture, daily life, jobs etc. in their countries. The YSM made a great success in establishing friendship between new friends and promoting friendship between old friends among the young scientists in AsiaFlux community.

Field Excursion

After the workshop, a one-day trip to Dinghushan site was held on December 4. The Dinghushan station, a subtropical forest site, is a flux monitoring and long-term ecological research station located in the beautiful Dinghushan National Natural Reserve. About 120 participants visited this site. Through the descriptions by the researchers of the local host, South China Botany Garden, CAS, participants learned the goals, designs, and achievements of the flux measurements of this site (Fig. 3). Participants also enjoyed the beautiful scenery of this natural reserve on their way back.

Fig. 3 Visiting the flux tower at the Dinghushan site.

Acknowledgements

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The Workshop proceedings can be viewed at the workshop web site and, after the workshop web site is closed, at AsiaFlux web site.

AsiaFlux Workshop 2010
http://asiaflux2010.csp.escience.cn/

AsiaFlux
http://www.asiaflux.net

Report of the "Symposium on the Use of New Techniques to Understand Gas Exchange and Carbon Dynamics in the Forest Ecosystem, Kyoto 2010"

Yoshiko Kosugi[1], Masako Dannoura[1], and Daniel Epron[2]

[1]Kyoto University, Japan
[2]Nancy University, France

Symposium on the Use of New Techniques to Understand Gas Exchange and Carbon Dynamics in the Forest Ecosystem was held on 1 November, 2010 at Kyoto University in Kyoto, Japan (Fig. 1). This symposium took place in the frame of a bilateral cooperation project between FRANCE (Institut National de la Recherche Agronomique, INRA) – JAPAN (Japan Society for the Promotion of Science, JSPS) on 'the use of stable carbon isotope to understand the carbon cycle in the forest' (2009-2010, PIs: Daniel Epron and Yoshiko Kosugi). During 2009, we also had a similar symposium in Nancy (Fig. 2), and MoUs were signed between Nancy University and Kyoto University, and also between INRA and Forestry and Forest Products Research Institute (FFPRI, Japan) to promote future collaborations.

The coupling of new techniques and methodologies, such as the use of stable isotopes, ecological monitoring and modeling, should be needed, together with sink/source flux observations at the scale of leaf, plant, soil, and also at the scale of whole canopy and ecosystem, to understand the carbon dynamics in forests. Various new techniques for gas exchange observation are therefore one of important key factors for the evolution in the area. This symposium discussed the new techniques and methodologies in the area of gas exchange and flux study, for the better understanding of the carbon dynamics in the forest ecosystem.

About 65 scientists and engineers from Japan and France participated in the symposium. We had 9 oral presentations in the morning, and 17 poster presentations in the afternoon.

The oral session focused on the use of stable isotopes (^{13}C, ^{18}O, ^{15}N) to understand the carbon cycle and gas exchange in the forest. Prof. Daniel Epron from Nancy University reported on species differences in seasonal variations of the amount of carbon allocated to respiration after in situ $^{13}CO_2$ pulse labeling of whole trees. Dr. Akira Kagawa at FFPRI introduced the process of carbon isotope signal transfer from leaves to tree rings and Dr Stephane Ponton from INRA showed intra-annual stable isotope signals in tree-ring cellulose of *Fagus sylvatica* over the 8-year period. Bernard Longdoz from INRA explained how a multi-scale approach using a combination of different techniques can improve our understanding of the C budget in a temperate beech

Figure 1. Memorial Photo of the Symposium

SCIENCES — nancy

Le carbone piégé en forêt lorraine

Le laboratoire « Ecologie et écophysiologie forestière » de Nancy a mis au point une technique pour tracer le carbone dans chaque compartiment de l'arbre, feuilles, branches, racines et sol.

Pister le carbone dans le cycle de l'arbre en forêt, telle est la mission du laboratoire « Ecologie et écophysiologie forestière » de Nancy. Derrière celle-ci se profile le réchauffement climatique, dû en partie au CO2 émis par les actions humaines et relâché dans l'atmosphère.

Le labo nancéien a mis au point une technique pour tracer le carbone dans chaque compartiment de l'arbre, feuilles, branches, racines et sol. L'originalité de la technique lorraine consiste à faire les expériences en forêt. « *On place sur le feuillage une toile plastique souple qui enveloppe les feuilles. Pendant deux heures, au moyen d'un système de climatisation fabriqué sur mesure, on injecte du carbone 13, un isotope stable non radioactif du carbone 12* », détaille Daniel Epron, directeur de l'unité mixte de recherche Ecologie et écophysiologie forestière. Au lieu d'ausculter des arbres en laboratoire, ses chercheurs travaillent en forêt lorraine. Ils emballent les arbres, comme l'artiste Christo le pont Neuf, et installent leur spectromètre à diode laser au bien des plantations. Ce travail réalisé en commun avec des labos d'Orsay et de Bordeaux a été retenu par l'Agence nationale de la recherche au titre du Programme blanc. « *Le label nous octroie une subvention de 400 000 euros pour les trois équipes sur trois ans* », poursuit le chercheur. De quoi faire un bon bout de chemin.

Si les arbres sont des réceptacles à carbone, l'élément leur sert pour faire fonctionner leurs cycles de vie. « *La façon dont le CO2 de l'atmosphère est absorbé par les plantes nous intéresse. Que devient-il dans les plantes ? Où se stocke-t-il ? A quelle vitesse ? Combien de temps ?* », s'interroge le biologiste. La méthode lorraine doit élucider ces questions. Derrière elles, se profilent d'autres enjeux pour les forestiers, ceux de la gestion des massifs. Quels arbres faut-il introduire pour assurer un meilleur stockage du carbone, tout en tenant compte d'autres paramètres, comme le taux d'azote ou d'eau ? La réponse n'est pas pour tout de suite. Des scientifiques japonais assistent au symposium, la méthode lorraine pourrait s'épanouir du côté de Kyoto.

M.- O. N.

Photo Clotilde VERDENAL

L'équipe du laboratoire « Ecologie et écophysiologie forestière » de Nancy collabore avec des chercheurs japonais, de l'université de Kyoto.

Le laboratoire Ecologie et écophysiologie forestière est une unité mixte de recherche de l'université Henri-Poincaré et de l'Inra.

Figure 2. Last Symposium at Nancy 2009 and our bilateral cooperation project between FRANCE (INRA) – JAPAN (JSPS) was reported in a French newspaper.

forest and Dr. Ryuichi Wada at Nagoya University showed their recent observation campaign of real-time, continuous measurements of CO_2 and H_2O isotopic compositions at Fujiyoshida forest meteorology research site (http://www.asiaflux.net/network/003FJY_1.html). Dr Caroline Plain from Nancy University exposed a new experimental design that has been developed to measure continuously the isotope composition of CO_2 in the soil atmosphere at different depths. Dr. Yuko Hanba at Kyoto Institute of Technology introduced the effect of mesophyll CO_2 conductance on leaf-scale gas exchange of C3 plants. Dr. Masayuki Itoh at Kyoto University talked about the CH_4 emission from the wetland in Kiryu Experiment Watershed (http://www.asiaflux.net/network/011KEW_1.html), introducing a strategy using $\delta^{13}C$ of pore water CH_4 and CO_2 to analyze the production pathways of CH_4. Dr Pascale Maillard from INRA introduced experiments of ^{15}N labeling that have permitted to partition N source (stored nitrogen versus newly assimilated nitrogen) for branch growth in spring in 50 year-old oak trees.

In the poster session, we had 5 presentations on the use of stable isotopes with various strategies, 5 presentations on the ecosystem respirations, 2 presentations on the coupling of modeling and flux observation, 5 presentations on the front-line techniques of flux observation of trace gases such as CH_4 and isoprene both at the canopy and at compartment scales.

From the new insights presented during this symposium, it is clear that rapid methodological development in the field of stable isotope and trace gas monitoring will profit to our research on ecosystem carbon dynamics in the following years. Our proposal from this symposium is that it would be very important to continue to share/take new strategies among the French and Japanese scientific communities for a better understanding of both flux/gas exchange and ecosystem dynamics in a changing climate system and to challenge considerable uncertainties that still remains concerning the fate of carbon in forest ecosystems.

Report of "Biogenic trace gas workshop 2010"

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Biogenic trace gas includes reactive volatile organic compounds isoprene and monoterpenes, greenhouse gas species CH_4 and CH_3Cl, inorganic gas species NH_4 and N_2O, and other trace gas components. Some of them are highly reactive in the atmosphere and contribute to the formation of photochemical pollutants and organic aerosols. Some of the others are greenhouse gases and influence the radiation balance of earth.

A meeting "Biogenic trace gas workshop 2010" was held at Kyoto, Japan, on 15-16 November 2010. This was the second meeting following the first meeting held in 2008. "Biogenic trace gas workshop 2010" was aimed to gather researchers studying biogenic trace gas at one place and to provide an opportunity for them to discuss problems associated with the ongoing studies and future collaboration.

Twenty two research results were presented in the meeting, and some of them are listed below.

- Methyl chloride emission and uptake by tropical and subtropical ecosystems
  Takuya Saito (NIES)
- Isoprene flux measurement by relaxed eddy accumulation method in a temperate mixed deciduous forest
  Kazuhiro Kinoshita (Kyoto University)
- NH_4 emission from rice leaves
  Kentaro Hayashi (NIAES)
- Organic aerosols produced from isoprene in a forest area
  Motonori Okumura (Kyoto University)
- Inventory of monoterpene and sesquiterpene emissions over Japan
  Sou Matsunaga (JPEC)
- Carbonyl sulfate emitted from *Brassica* spp.
  Yoko Katayama (TUAT)
- Effect of ozone and CO_2 on isoprene emission from *Quercus serrata* and *Q. crispula*
  Tasuku Saito (University of Shizuoka)
- Dimethyl sulfide (DMS) concentration across South Pacific Ocean measured with a proton transfer reaction mass spectrometer
  Seiji Koga (AIST)

In the afternoon of the second day, participants visited Yamashiro flux towers managed by Forestry and Forest Products Research Institute (FFPRI). They looked around the site and were explained about two flux towers, soil chambers and various instruments for the continuous measurements. The next meeting is scheduled to be held in 2012 and everybody who has interests in biogenic trace gas research will be welcome.

Figure 1. One of two flux towers located at Yamashiro,

Micrometeorological measurements of heat, water, and CO_2 exchanges at an urban landscape in Sakai, Japan

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Introduction

Urban environment has various important aspects; 1) most of the world's population is living in urban areas, 2) influences of urbanization on climate and pollutants affect human health and amenity, and 3) urban landscapes are suspected to be major sources of anthropogenic CO_2. To accurately estimate global energy, water and carbon exchanges, long -term monitoring of those fluxes has been conducted in many terrestrial ecosystems (Baldocchi, 2008). Through these flux measurements, we have much understanding of processes related with biosphere-atmosphere interactions (Valentine et al., 2000; Hirata et al., 2008). On the other hand, the exchange processes in urban landscapes contain large uncertainties due to lack of continuous measurement.

Previously, several studies have conducted flux measurements in urban landscapes in Marseille (Grimmond et al., 2004), Edinburgh (Nemitz et al., 2002), Mexico City (Velasco et al., 2005), and Basel (Vegt et al., 2006) as well as in a residential area of Tokyo (Moriwaki et al., 2004) and in an urban park area of Germany (Kordowski and Kuttler, 2010). According to the website of Urban Flux Network (http://www.geog.ubc.ca/urbanflux/), however, only limited sites are currently monitoring fluxes in urban landscapes, because many of the measurements in urban areas were based on short

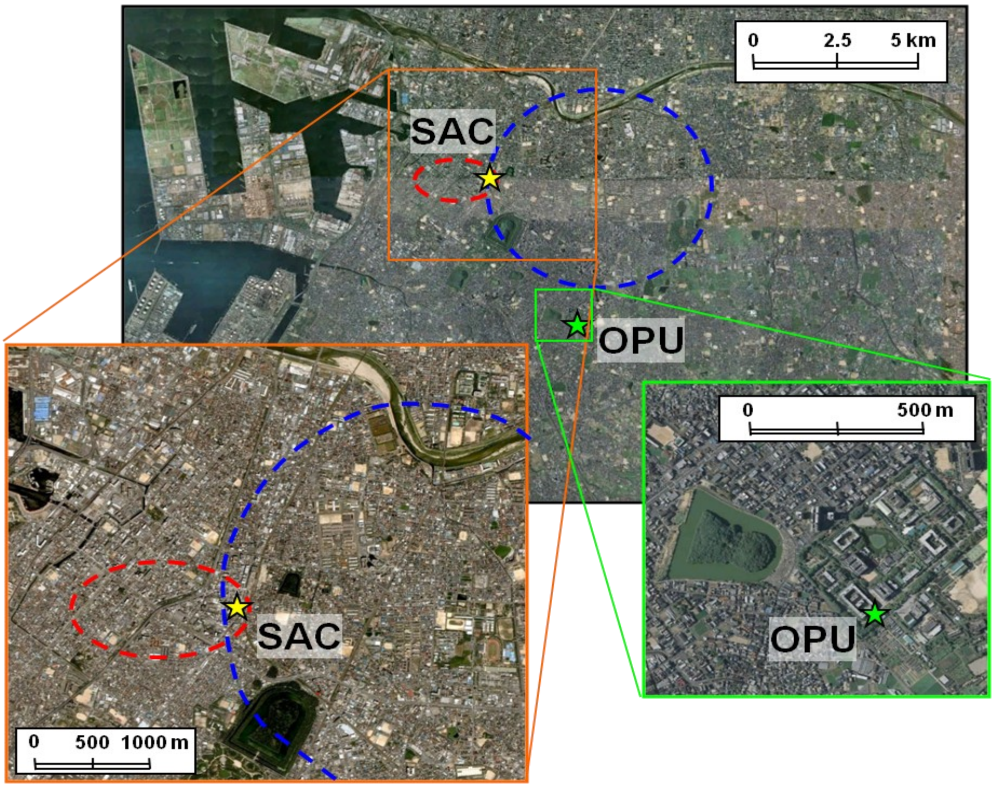

Figure 1. Location of the observation sites at the Sakai City Hall (SAC), and Osaka Prefecture University (OPU). The red and blue dashed-line circles represent typical daytime and nighttime flux source areas, respectively. The map is obtained from the Google Earth©.

-term field campaigns rather than on continuous monitoring. Lack of continuous measurements constrains the availability of validation data for urban climate models, and limits our understanding of energy and trace gas exchanges in urban canopies.

To quantify the urban fluxes and the related processes, we started to measure the fluxes of sensible heat, water vapor, and CO_2 in a highly built-up urban landscape. In this article, we introduce the characteristics of our urban flux sites and our flux measurement methods.

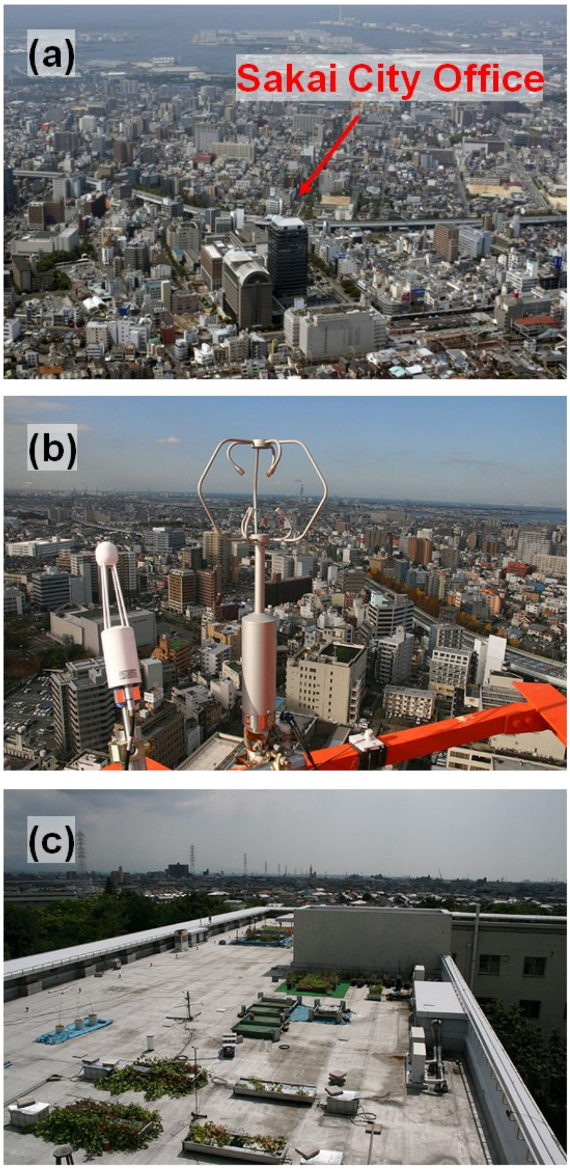

Figure 2. Photographs showing landscapes around the city hall (a), the eddy covariance system at the tower (b), and ancillary measurements at the roof top in Osaka Prefecture University (c).

Study sites

Sakai is the second biggest city in Osaka, Japan, and its population exceeds 800,000. The city is selected as an Eco-Model city, which is a municipality designated by Japanese government to challenge pioneering initiatives for low-carbon society.

The study site was established in the city center of Sakai (34˚34’25’’N, 135˚8’80’’E, elevation 17 m), where there are many of commercial buildings, major arterial roads and highways with heavy traffic during daytime (Figs. 1 and 2a). The area is on a uniformly flat plane; north-south and east-west slopes are 0.0030˚ and 0.0024˚, respectively. The mean building height within the area is about 7 m, based on the number of building stories. The mean annual air temperature and total precipitation are 15.6˚C and 1206.9 mm year^{-1}, respectively, between 1979 and 2000, according to a weather station of Japan Meteorological Agency.

The flux footprint of the site, examined by an analytical footprint model (Kormann and Meixner, 2001) (Figs. 1 and 3), includes commercial, industrial and residential areas with a little vegetation. Located on the eastern coast of Osaka Bay, the wind comes from west of the city in the daytime and from east in the nighttime due to a land and sea breeze. Thus, the daytime and nighttime source areas have different sizes and directions, because of the differences in atmospheric stability and wind direction. The source area during the daytime mainly consists of commercial areas, whereas most of the nighttime source area is residential area.

For studying the detailed processes related to urban energy exchanges, we established another site in Osaka Prefecture University (34˚32’41’’N, 135˚30’16’’E, elevation 28 m a.s.l.), which is characterized as suburban area of Sakai city (Fig.1). This site is approximately 3.76 km of south-east direction of the city center site.

Field observations

We measured fluxes of sensible heat, water vapor, and CO_2 at a 16 m tower on the roof top of the Sakai city hall, since November 2008 (Table 1; http://www.asiaflux.net/network/076SAC_1.html). The eddy covariance measurement has been conducted at 111 m above the ground (15 m above the roof top) using a sonic anemometer (SAT-500, Kaijo, Japan) and an open-path gas analyzer (LI-7500, Li-Cor, USA) (Fig.2b). The turbulent data has been

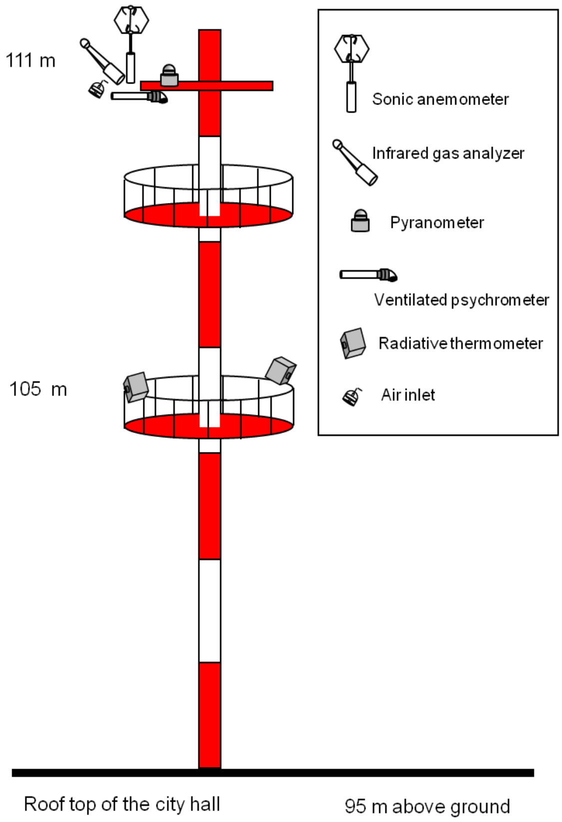

Figure 3. Installation of the instruments at the city hall of Sakai.

recorded at 10 Hz by a datalogger (Model 8421, Hioki, Japan), and averaged for 30-minute period. Other meteorological variables has been measured at the tower; air temperature and humidity (HMP45C, Vaisala, Netherlands), and solar radiation (ML-02VM, Eko, Japan). Surface temperature in west and east directions have been measured by two radiative thermometers (IT-450, Horiba, Japan). CO_2 concentration at 111 m was measured by an infrared gas analyzer (LI-840, Li-Cor, USA). The vertical profile of CO_2 concentration inside the canopy has been measured at a building in front of the city hall. Air has been collected from inlets at 27.3, 16.7, 12.7, and 7.8 m above the ground to an infrared gas analyzer (GMP343, Vaisala, Netherlands) at flow rate of 1 liter per minute, where the flow line has been switched by a solenoid value (USB3-6-3-E, CKD, Japan). The meteorological and CO_2 concentration data have been sampled at 1 minute, and the 30-minute average has been recorded by dataloggers (CR1000, Campbell, USA).

Ancillary data has been measured at the site in Osaka Prefecture University (Fig.2c; Table 1). Meteorological variables have been measured at the roof top of a building (16 m tall); wind speed and direction (Model 81000, Young, USA), air temperature and humidity (HMP50, Vaisala, Netherlands), rainfall (WB0015, Nakase, Japan), components of net radiation (MR-40, Eko, Japan), radiative surface temperature of grasses in an inner garden (IT-450, Horiba, Japan), and surface temperature of the roof by thermocouple thermometer. Ground heat fluxes have been measured at ground, roof top, and wall surface by calibrated thermo-modules (TEC-3105, Kyohritsu, Japan). The evaporation from a concrete block has been measured by a weighting method with a platform scale (HJ-15KJS, ViBRA, Japan).

Future directions

Since the start of the measurement in fall 2008, we have collected more than 2-year semi-continuous records of the fluxes and meteorology. Now, we can start analyzing the data to clarify the processes, such as the diurnal, seasonal and interannual variations, the characteristics in mass and energy exchanges, and the various effects of human footprint. This dataset could be useful for validating urban climate models, developing CO_2 emission inventories, ground truth of satellite remote sensing, and other studies. We welcome other groups to collaboration with us for understanding the urban processes by using the urban flux data.

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Table 1. Measured variables, sensors, heights and terms.

Site	Variable	Sensor	Height (m)	Term
SAC	Sensible heat flux	81000 (Young)	111	2008.11.14 - 2009.3.18
		SAT550 (Kaijo)	111	2009.3.18 - present
	Latent heat flux	SAT550 (Kaijo), LI-7500 (Li0Cor)	111	2009.11.24 - present
	CO_2 flux	SAT550 (Kaijo), LI-7500 (Li0Cor)	111	2009.11.24 - present
	Air temperature	HMP45C (Vaisala)	111	2009.3.18 - present
	Relative humidity	HMP45C (Vaisala)	111	2009.3.18 - present
	Solar radiation	ML-02VM (Eko)	111	2009.3.18 - present
	Surface temperature (west side)	IT-450 (Horiba)	105	2009.3.18 - present
	Surface temperature (east side)	IT-450 (Horiba)	105	2009.6.3 - present
	CO_2 concentration	LI-840 (Li-Cor)	111	2008.11.14 - 2009.5.31
		GMP343 (Vaisala)	27.3, 16.7, 12.7, and 7.8	2010.6.16 - present
OPU	Wind speed & direction	81000 (Young)	21.35	2008.11.13 - present
	Air temperature	HMP50 (Vaisala)	0.9 above the roof top*1	2009.5.8 - present
	Relative humidity	HMP50 (Vaisala)	0.9 above the roof top*1	2009.5.8 - present
	Component of net radiation	MR-40 (Eko)	0.9 above the roof top*1	2009.2.23 - present
	Surface temperature of grass	IT-450 (Horiba)	21	2009.5.12 - present
	Surface temperature of roof	thermocouple thermometer	0.0 above the roof top*1	2009.7.27 - present
	Rainfall	WB0015 (Nakase)	0.0 above the roof top*1	2009.4.7 - present
	Ground heat flux	TEC-3105 (Kyohritsu)	0 and 16	2009.7.28 - present
	Evaporation	HJ-15KJS (ViBRA)	0.3 above the roof top*1	2009.5.15 - present

*1 The height of the roof surface is 16 m.

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A Year-Round Flux Observation at an Area Burned by Wildfire in Interior Alaska

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Wildfire in boreal region

Wildfire is a major disturbance in boreal forests. It attracts research attention not only because it instantaneously releases a large amount of carbon into the atmosphere, but also because it significantly alters hydrology and carbon exchange at the land surface over a decadal timescale during the vegetation succession after wildfire. The change of energy fluxes directly affects the local climate and, together with the carbon release, may influence the larger-scale climate. The occurrence of wildfire is closely coupled to climate patterns (Flannigan and Harrington, 1988), and therefore climate change will, in turn, influences the fire regime. It has been reported that the area burned by wildfire in the North American boreal forest has increased almost threefold over the past two decades (Kasischke and Stocks, 2000). To understand the role of wildfire, considerable researches were conducted in boreal forest chronosequence (e.g., Burke et al., 1997; Chambers and Chapin III, 2002; Litvak et al., 2003; Wang et al., 2003; Bond-Lamberty et al., 2004; Amiro et al., 2006, 2010; Welp et al., 2006; Liu and Randerson, 2008; Mack et al. 2008; Goulden et al., 2010). However, relatively little is known about the dependence of energy, water, and carbon fluxes on weather variability and fire severity at early stage of vegetation succession.

Figure 2. An aerial photograph of the Poker Flat site taken in July 2010. The star mark indicates the location of instruments. The photo was taken by Isao Yuguchi.

Since autumn 2002, we have conducted a continuous observation of energy, water, and carbon fluxes and micrometeorological variables in a mature black spruce forest in Interior Alaska. Through the analysis of field data (Ueyama et al., 2006a, b; Kim et al., 2007; Iwata et al., 2010), application of a terrestrial ecosystem model (Ueyama et al., 2009), and analysis of data with remote sensing imagery (Kitamoto et al., 2007; Date et al., 2009; Ueyama et al., 2010), we have been clarifying the role of black spruce forests in energy and carbon exchanges. Alaska is greatly affected by wildfire (Fig. 1). From 2000 to 2009, approximately 77,000 km^2 (AICC, 2009), an area about the size of Hokkaido Island, Japan, was burned. Accurate quantification of energy, water, and carbon exchanges in these burned areas is needed to understand the influence of wildfire on boreal forest ecosystems. This need inspired us to commence a study of energy and

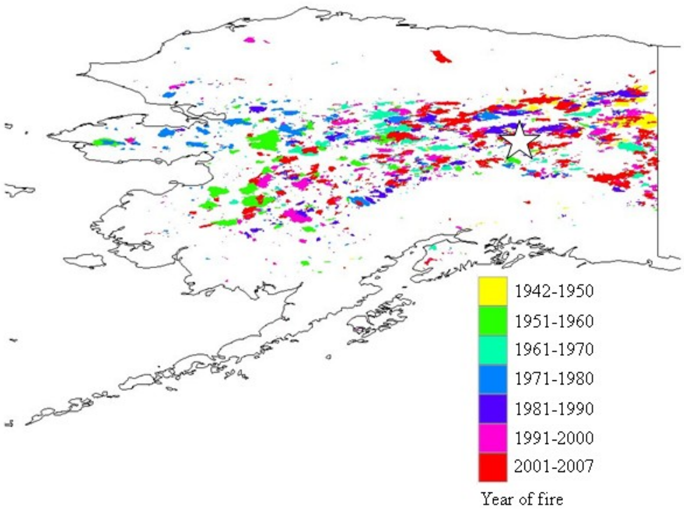

Figure 1. Fire history in Alaska and the location of Poker Flat Research Range indicated by the star mark. Fire history data were provided by Alaska Fire Services.

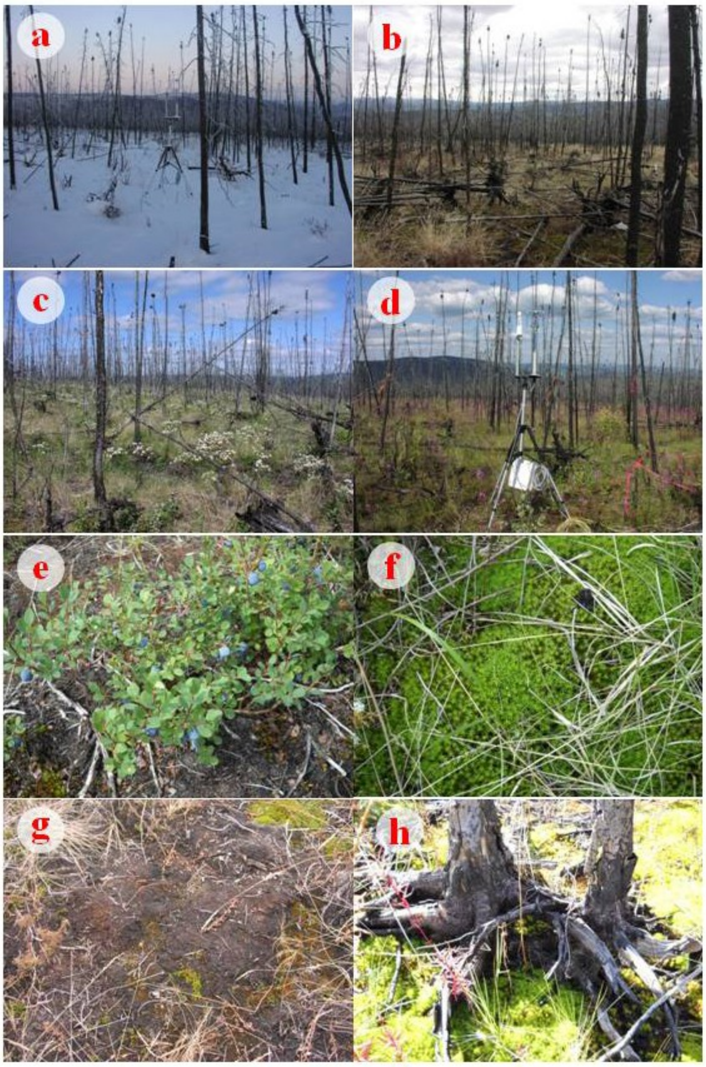

Figure 3. Photographs taken at the Poker Flat site: (a) winter season (December 11, 2008), (b) just after snowmelt (May 12, 2009), (c) blossom of Labrador tea (June 10, 2009), (d) blossom of fireweed (July 21, 2009), (e) blueberry, (f) moss, (g) bare soil, and (h) adventitious roots of black spruce, whose distance to the mineral soil layer was used to assess the consumption of the organic layer during fire.

carbon exchanges in a burned area in Interior Alaska. In this article, we will describe the study site and the observations, and present some preliminary results. The observed micrometeorological variables and fluxes in the burned area were compared with those observed in the mature black spruce forest.

Study site, and flux and micrometeorological observations

The study area is located in the Poker Flat Research Range of the University of Alaska Fairbanks, Interior Alaska (Figs. 1 and 2). A wildfire named the "Boundary Fire" started in this area in the middle of June 2004 and continued until management efforts extinguished it in early August 2004. The fire burned almost 2,170 km^2 (Kasischke et al., 2008) in an area that was vegetated with black spruce before the wildfire. We started the flux observation using the eddy covariance technique, with relevant micrometeorological observations, in August 2008 at a severely burned site (65˚08'N, 147˚26'W, 491 m a.s.l.) within the burned area (cited hereafter as the PF site). The PF site is located on a relatively flat, gentle north-facing slope (about 4 degrees). The depth of the pre-burn soil organic layer and the consumption of soil organic layer during the fire were approximately 30 and 28 cm, respectively, estimated from the distance of adventitious roots (Fig. 3h) to the mineral soil layer (Kasischke et al., 2008). Around the observation mast, almost none of the black spruce survived after the fire, but most of the dead trees remained standing (Fig. 3a-d). The dominant vegetation species at the PF site are listed in Table 1.

The climate in Interior Alaska is strongly continental, with a minimum monthly mean air temperature of -23.2 ℃ in January and a maximum of 16.9 ℃ in July. The average annual precipitation is 263 mm measured at Fairbanks International Airport (Shulski and Wendler, 2007). The snow cover usually starts in October, and complete snowmelt occurs in late-April. The complete snowmelt corresponds to the start of growing season in the sub-arctic ecosystems.

A three-dimensional ultra-sonic anemometer and an open-path infra-red gas analyzer were mounted at the height of 2.6 m to observe turbulent fluctuations of wind velocities, temperature, water vapor density, and carbon dioxide density (Fig. 4). Micrometeorological variables such as air temperature, relative humidity, incident and reflected short-wave radiation, incident and reflected photo-synthetically active radiation (PAR), net radiation, rainfall, ground surface temperature, soil heat flux, soil temperature, and soil water content were also observed. Power available at this site enabled us to conduct year-round observations.

Table 1. The dominant vegetation species at the PF site.

Trees
White birch (*Betula neoalaskana*)
Trembling aspen (*Populus tremuloides*)
Black spruce (*Picea mariana*)
Shrubs
Labrador tea (*Ledum groenlandicum*)
Bog blueberry (*Vaccinium uliginosum*)
Bog cranberry (*Vaccinium vitis-idaea*)
Grey-leaved willow (*Salix glauca*)
Herbs and ferns
Sedge (*Carex bigelowii*)
Fireweed (*Epilobium angustifolium*)
Bluejoint (*Calamagrostis canadensis*)
Bunchberry (*Cornus canadensis*)
Mosses
Purple horn-toothed moss (*Ceratodon purpureus*)
Slender hair-cap (*Polytrichum strictum*)

Preliminary results

In this article, the characteristics of micro-meteorology and energy, water, and carbon exchanges at the PF site in 2009 will be compared to those at the mature forest site (64˚52'N, 147˚51'W, 155 m a.s.l.) observed in the same year. The mature forest is located on the campus of University of Alaska Fairbanks (cited hereafter as the UAF site), 34 km southwest of the PF site. In brief, the black spruce forest is about 120 years old (Vogel et al., 2005) with a thick organic layer of 25-45 cm. The forest stands on permafrost soil, and the depth of the active layer is 40-50 cm. The site is located close to a valley bottom. Readers are referred to a previous AsiaFlux Newsletter (Ueyama and Harazono, 2007) for more details.

The flux data obtained at both sites were gap-filled using a simple regression method. The energy fluxes were gap-filled using a linear re-gression between energy fluxes and radiation, and CO_2 flux was gap-filled using a light response equation for daytime and a temperature-dependent respiration equation for nighttime.

Micrometeorological conditions

Daily mean air temperatures were similar at both sites from March through October. However, during winter, daily mean air temperature was higher at the PF site due to higher elevation and a strong inversion layer, which typically develops during winter in Interior Alaska. Daily mean soil temperature at the PF site in mid-summer was about 4 ℃ higher than that at the UAF site at 10 cm depth. The difference at greater depth was more significant. Soil temperature at the PF site at 90 cm depth increased up to 9 ℃ at the end of summer, while soil temperature at the UAF site at 80 cm depth was only slightly above 0 ℃. At the UAF site, soil temperature measurements at 120 cm depth indicated that permafrost is present deep in the soil. This remarkable difference in the soil temperature is a result of whether or not the ground is covered by thick moss and an organic layer, which provide effective insulation. At the PF site, severe wildfire burned most of the moss and organic layer. During winter, the snow layer has similar insulating effects as the organic layer, but at the PF site, higher air temperature resulted in higher soil temperature.

Wind speed was generally higher at the PF

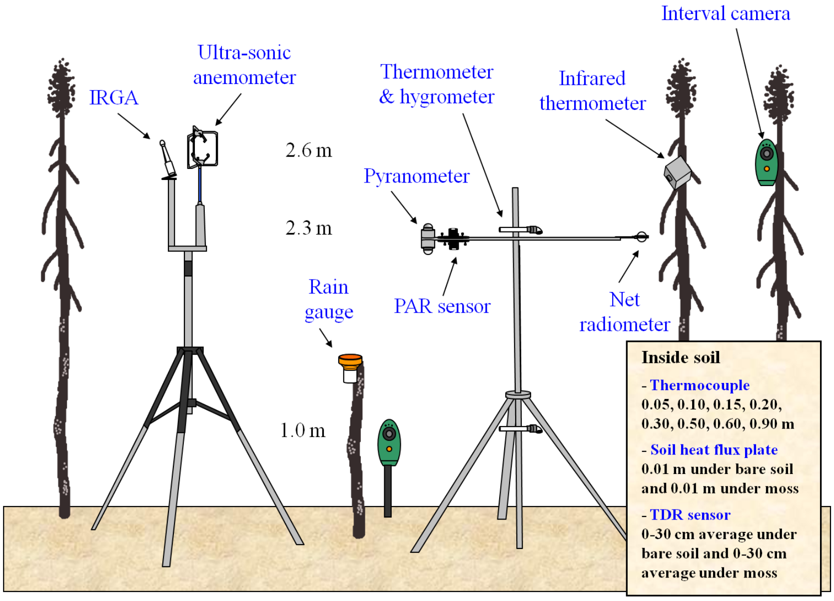

Figure 4. Instrumentation at the Poker Flat site.

site, with several high wind conditions observed during winter. High wind conditions are an advantage to conducting a flux observation with a micrometeorological technique such as the eddy covariance.

Soil water content (SWC) is another significant difference between the sites. Although the amount of precipitation was similar at both sites, SWC was lower at the PF site (0.2 during summer). This difference is attributable to the position of the sites on the slope; the PF site is located close to a hilltop, while the UAF site is near a valley bottom. The presence of permafrost also plays an important role in the accumulation of soil water; permafrost blocks deep percolation at the UAF site. Winter precipitation was similar at both sites, but higher winds at the PF site blew the snow away, leading to less accumulation. Complete snowmelt occurred at the end of April at both sites. Other meteorological variables such as solar radiation, rainfall, and water vapor pressure deficit (VPD) at the PF site showed variations similar to those at the UAF site. To summarize, the large difference between the sites is the soil environment, which is expected to influence energy and CO_2 exchanges significantly, and not the atmospheric conditions except winter air temperature and wind.

Energy and CO_2 fluxes

A comparison of observed energy fluxes at both sites showed a clear difference in energy partitioning in the early growing season (from complete snowmelt to mid-June). In this season, about the same fraction of the available energy was partitioned to both sensible heat flux, H, and latent heat flux, λE, at the PF site, while nearly a threefold fraction of the available energy was partitioned to H compared to λE at the UAF site. The seasonal peak of λE in mid-summer was less clear at the PF site. This is attributable to a lower evapotranspiration rate affected by drought conditions that occurred in July 2009. During winter, an occasional large downward H of up to -4 MJ m^{-2} day^{-1} was observed at both sites. This is probably related to a break of the strong inversion layer by high wind, since these large downward transports are associated with high wind speed conditions. A large upward λE was also observed simultaneously with the large downward H; otherwise, λE during winter was close to zero.

Gross primary productivity (GPP) and ecosystem respiration (RE) showed similar seasonal patterns at the PF site and the UAF site. Their seasonal peaks occurred in July in response to high radiation and high temperature. However, the amplitudes of GPP and RE were different at the two sites; both GPP and RE were smaller at the PF site than at the UAF site. The maximum GPP in mid-summer was 12.8 and 24.5 gCO_2 m^{-2} day^{-1} at the PF site and the UAF site, respectively. The maximum RE was 9.2 and 20.0 gCO_2 m^{-2} day^{-1} at the PF site and the UAF site, respectively. The lower GPP and RE at the PF site were due to the lower amount of vegetation, which uptakes CO_2 through photosynthesis and also respires CO_2. The lower content of organic carbon in the soil after the severe fire is also attributable to the lower RE at the PF site.

Future directions

Preliminary results imply that the PF site, compared to the UAF site, may experience larger interannual variations in energy fluxes in response to summer drought. The amount of precipitation may strongly influence the growth of vegetation after wildfire. We will continue the flux observations to clarify the effect of drought on vegetation growth at the PF site. We also need to evaluate CO_2 exchange on a regional scale, including areas burned by wildfire. As mentioned at the beginning of this article, we lack information on the influence of fire severity on energy, water, and carbon exchanges after wildfire. To clarify this influence, we are planning to conduct observations of energy and CO_2 exchanges at different burned areas within Interior Alaska. This information is needed to reveal the effects of wildfire on high-latitude ecosystems.

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Editor's Note

AsiaFlux Workshop in Guangzhou was a great opportunity to talk with various scientists. I hope this Newsletter will promote further communi-cations in AsiaFlux. Many thanks to the contributors in this issue.

The Editor of
AsiaFlux Newsletter No. 32
Masahito Ueyama
(Osaka Prefecture Univ., Japan)

The Editor of AsiaFlux Newsletter No. 33 will be Dr. Ke-Sheng Cheng (National Taiwan University, Taiwan).

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