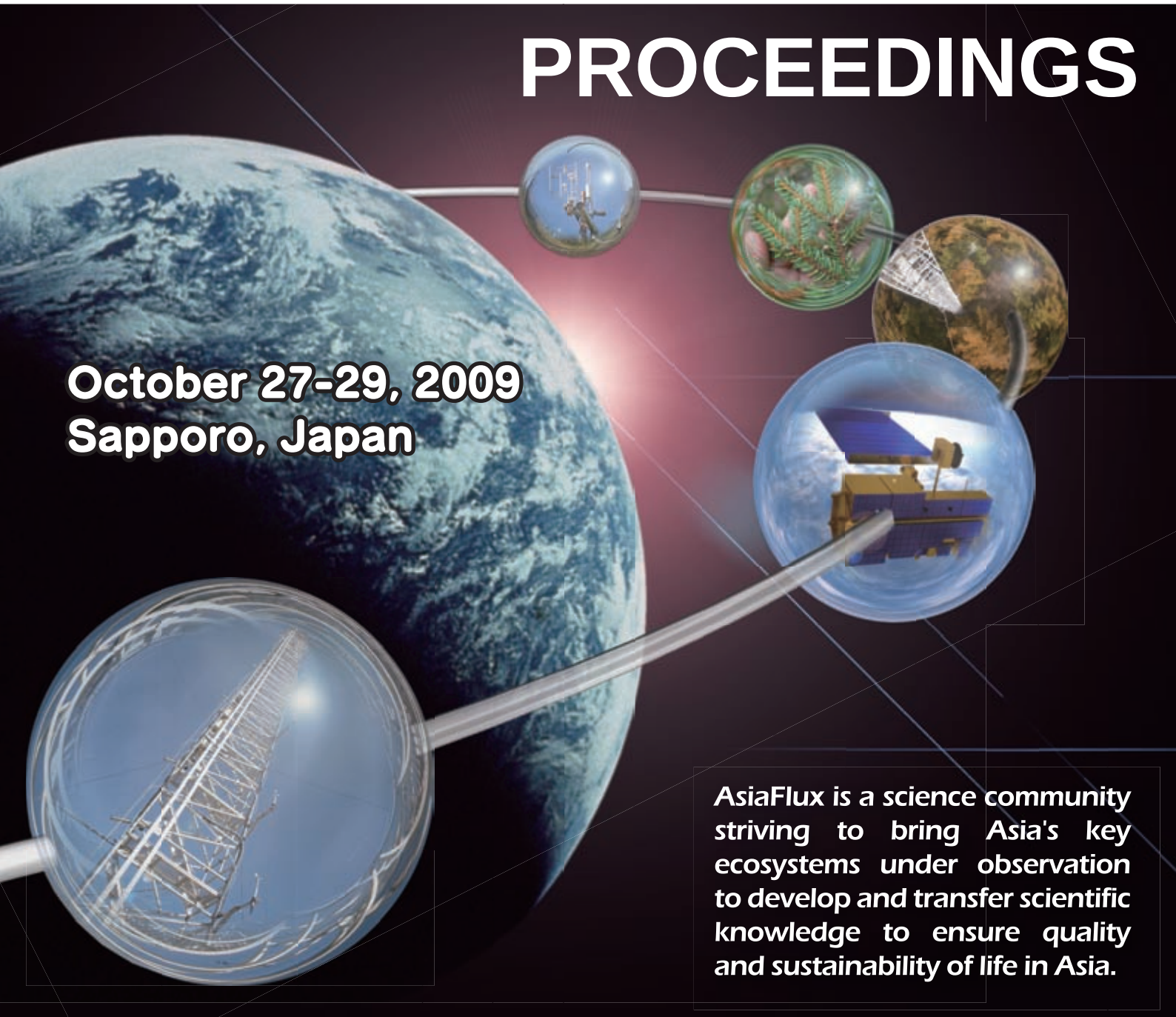
AsiaFlux Workshop 2009

Integrating Cross-scale Ecosystem Knowledge: Bridges and Barriers

PROCEEDINGS



October 27-29, 2009
Sapporo, Japan

AsiaFlux is a science community striving to bring Asia's key ecosystems under observation to develop and transfer scientific knowledge to ensure quality and sustainability of life in Asia.

AsiaFlux Workshop 2009

Integrating Cross-scale Ecosystem Knowledge: Bridges and Barriers

27-29 October 2009

Hokkaido University, Sapporo, Japan

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Integrating Cross-scale Ecosystem Knowledge: Bridges and Barriers

"Sum, ergo cogito (I am, therefore I think)!" This 'human-in-ecosystem' perspective is a way to think about the relationship between nature and society and about the interfaces between the two. Linking ecological and social systems is a cross-scale problem. In Asia, reaching a serviceable understanding of the sustainability, dynamics, vulnerability and resilience of these complex socio-ecological systems will require a stronger push to advance focused cross-disciplinary scientific research with a clear vision.

AsiaFlux is a science community with a mission to bring Asia's key ecosystems under observation to ensure quality and sustainability of life in Asia. It is the Asian arm of FLUXNET, the worldwide flux research network and one of the potential components of Global Earth Observation System of Systems (GEOSS). Our vision is to serve as the 'science frontier' in carbon, water, and energy cycles in Asia by developing and transferring scientific knowledge characterized by consilience, contextualization, and cultural diversity. By 2011, we aim to (1) provide a report on the Asian carbon (and water) budget with its global perspectives and (2) develop an infrastructure for Asian carbon (and water) tracking system (ACTS).

Our vision is processual, and it is an invitation to re-think global change science. In a beautiful city of Hokkaido in northern Japan, the local organizing committee has prepared an exciting program for the 8th AsiaFlux Workshop on "Integrating Cross-scale Ecosystem Knowledge: Bridges and Barriers." Science is currently going through a painful evolutionary process and a new concept of knowledge is emerging, based on the plurality of perspectives and awareness of complexity, uncertainty and values. So, here we invite you to our new community space in which science meets and interacts with others and where interests, values and decisions are discussed, fought over and perhaps settled. Welcome to the AsiaFlux agora!

Joon Kim, Guirui Yu and Akira Miyata
Chair & Vice-chairs of AsiaFlux

AsiaFlux Workshop 2009

Expand our Views through Collaboration with Other Research Communities

As the chair of the Local Organizing Committee, I am excited to host the 8th AsiaFlux Workshop at Hokkaido University in Sapporo, Japan during 27-29 October 2009. With increasing interests in the global change issues, we scientists are compelled to expand our views to the global biogeochemical context through collaboration with other network of research under the framework of Earth observing system, and offer the right scientific knowledge to society to answer socio-economic questions. In this workshop, we will explore the advantages of collaborations between flux research community and various other research communities specializing particularly in long-term ecological research, remote-sensing, and social science to 1) deepen our knowledge about ecosystems, 2) extend our knowledge to broader regions, and 3) extend the knowledge to the society. For this purpose, we organized several special sessions that feature collaborations with other networks, such as FLUXNET, iLEAPS, ILTER, and Remote sensing fields; and the flagship studies will be presented by invited speakers from these networks.

We also organized a session to share the recent progresses in the flux synthesis studies in Asia under CarboEastAsia program. CarboEastAsia is one of the A3 Foresight Programs that has been implemented to support international collaborations among global change scientists particularly from China, Korea and Japan. CarboEastAsia partnership, through synthesizing measurement, theory, and modeling in quantifying and understanding of carbon fluxes and storages in East Asia to cope with climate change protocols, is a true test bed for accomplishing AsiaFlux's vision to serve as the "Science Frontier" by developing and transferring scientific knowledge in carbon, water, and energy cycles in Asia.

The workshop is co-hosted by CarboEastAsia, and Hokkaido University Global COE Program "Establishment of Center for Integrated Field Environmental Science". This workshop will provide a great opportunity for scientists, students, policy-makers and the public to better understand the latest scientific achievements in the field of global change issues. We are looking forward to having you in Sapporo, sharing the latest knowledge, and discussing to cope with climate change protocols.

Takashi Hirano

Chair, AsiaFlux Workshop 2009 Local Organizing Committee

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Japan Long-Term Ecological Research Network (JaLTER)

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AsiaFlux Homepage

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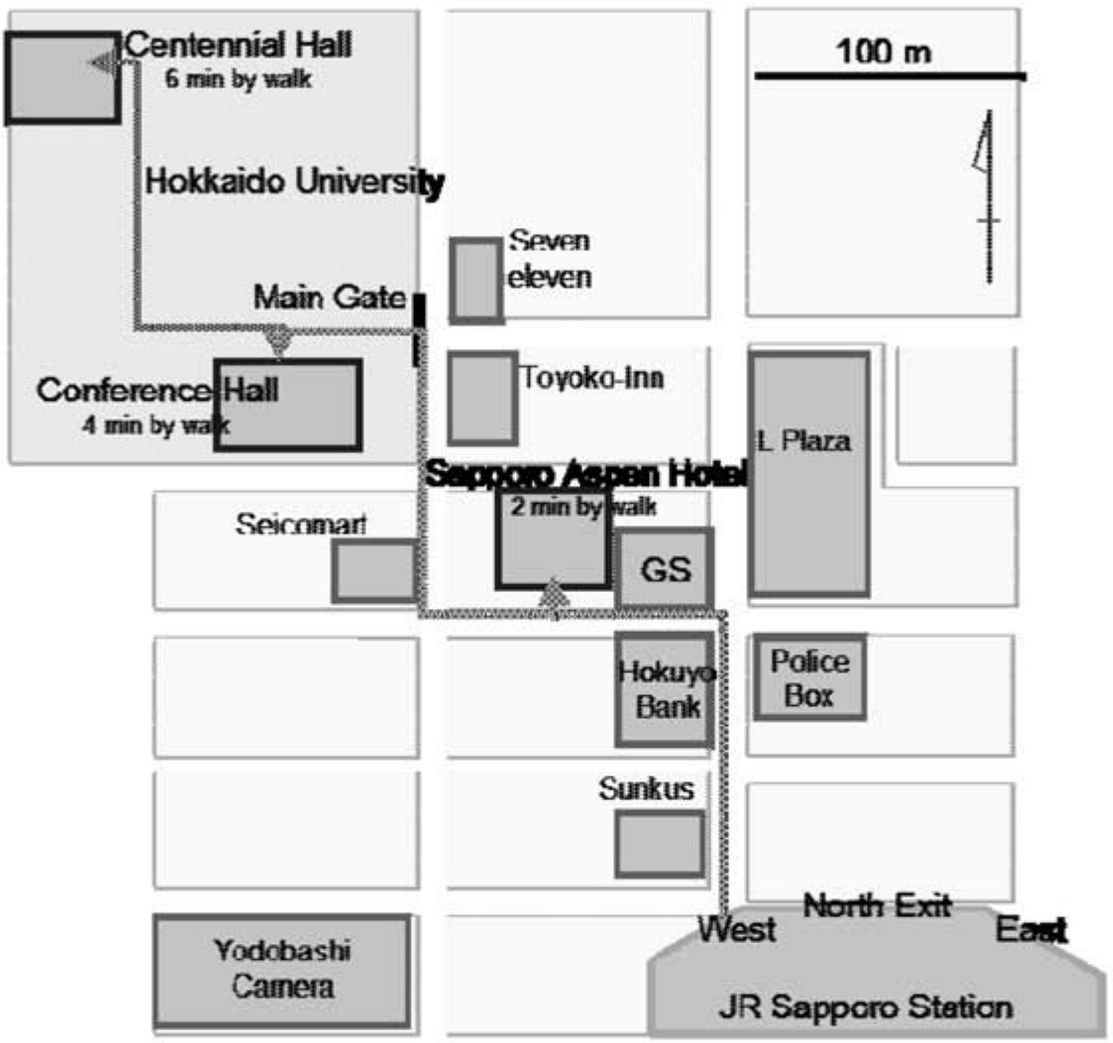
Map


Centennial Hall
6 min by walk
Hokkaido University
Main Gate
Conference Hall
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Seven eleven
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East
JR Sapporo Station
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AsiaFlux Workshop 2009 Program

October 27, 2009 (Tuesday)

Opening Session — October 27 09:00-10:50

Moderator: Takashi Hirano

Welcome Addresses

09:00-09:03		From the chair of local organizing committee	T. Hirano
09:03-09:17		From the chair of AsiaFlux	J. Kim
09:17-09:20		From sponsors	

Reports from Regional Flux Networks

09:20-09:35	O11	THAIFLUX	P. Kasemsap
09:35-09:50	O12	PROGRESS OF FLUX MEASUREMENT OF FOREST ECOSYSTEM IN TAIWAN	Y.-J. Hsia
09:50-10:05	O13	FLUX MEASUREMENTS: ROLE IN EMERGING CLIMATE CHANGE PARADIGM	S. Tripathi
10:05-10:20	O14	OZFLUX	R. Leuning
10:20-10:30	O15	BRIEF INTRODUCTION AND FUTURE DIRECTIONS OF CHINAFLUX	G. Yu
10:30-10:40	O16	CURRENT ACTIVITIES OF JAPANFLUX	T. Hirano
10:40-10:50	O17	KOFLUX REPORT 2009: IN RETROSPECT	H. Kwon

Oral Session I: CarboEastAsia — October 27 11:10-12:40

Chair: Naishen Liang and Jinkyu Hong

11:10-11:15		INTRODUCTION OF A3 CARBOEASTASIA PROGRAM	N. Liang
11:15-11:45	O21	*Invited*: SYNTHESIS ACTIVITIES WITHIN FLUXNET: FROM POINT TO GLOBE	M. Reichstein
11:45-12:00	O22	AN ASSESSMENT OF THE REGIONAL SCALE CARBON UPTAKE CAPACITY BASED ON CATCHMENT WATER BUDGET AND ECOSYSTEM SCALE WATER USE EFFICIENCY	D. Lee
12:00-12:15	O23	PARTITIONING OF EVAPOTRANSPIRATION WITH A TWO-SOURCE MODEL: FROM SITE SCALE TO REGIONAL SCALE	Z.M. Hu
12:15-12:30	O24	MULTI MODEL AND DATA ANALYSIS OF TERRESTRIAL CARBON CYCLE IN MONSOON ASIA: FROM 2001 TO 2006	K. Ichii
12:30-12:40		Discussion	

Oral Session II: Bridges between Ecosystem Observation and Remote Sensing — October 27 14:00-16:05

Chair: Kenlo Nishida Nasahara and Sinkyu Kang

14:00-14:15	O31	*Invited*: " J-INTER-COMMUNITY" FOR ECOSYSTEM STUDY BINDING FIELD WORK, MODEL, AND REMOTE-SENSING	K.N. Nasahara
14:15-14:30	O32	*JAXA Award*: ESTABLISHMENT OF BASELINE OF CARBON STOCK AND FLUXES ON TROPICAL PEATSWAMP FOREST AREA IN KAMPAR PENINSULA, RIAU, INDONESIA	O. Karyanto
14:30-14:45	O33	*JAXA Award*: MODELING ENERGY AND WATER FLUXES OVER INDIAN AGROECOSYSTEMS – BRIDGING GAP FROM CANOPY TO REGIONAL SCALES WITH SATELLITE BASED THERMAL REMOTE SENSING	B.K. Bhattacharya
14:45-15:00	O34	SPATIAL-TEMPORAL VARIATIONS AND ENVIRONMENTAL CONTROL FACTORS OF ECOSYSTEM LIGHT USE EFFICIENCY AMONG TYPICAL FORESTS IN EAST ASIA	W.X. Wu
15:00-15:15	O35	RELATIONS OF SPRINGTIME CANOPY DEVELOPMENT WITH CARBON AND WATER FLUXES IN A DECIDUOUS BROADLEAF FOREST	S. Kang
15:15-15:30	O36	NET PRIMARY PRODUCTION OF TROPICAL RAIN FOREST USING GLOBAL PRODUCTION EFFICIENCY MODEL AND ASTER SATELLITE DATA	M.A. Faidi
15:30-15:50	O37	*Invited*: KEEPING AN EYE ON THE CARBON BALANCE: LINKING CANOPY DEVELOPMENT AND NET ECOSYSTEM EXCHANGE USING AN INTERNATIONAL WEBCAM NETWORK	L. Wingate
15:50-16:05		Discussion	

Cancelled

October 28, 2009 (Wednesday)

Oral Session III: Barriers in Flux Measurements — October 28 08:45-10:25

Chair: Akira Miyata and Ray Leuning

08:45-09:15	O41	*Invited*: INSTRUMENT SURFACE HEAT EXCHANGE AND OPEN-PATH CO_2 FLUX	G. Burba
09:15-09:35	O42	*Invited*: EDDY COVARIANCE MEASUREMENTS OVER A PASTURE: COMPARISON OF OPEN- AND CLOSED- PATH GAS ANALYSERS AND THE ENERGY BALANCE CLOSURE PROBLEM	R. Leuning
09:35-09:55	O43	*Invited*: THREE ISSUES CONCERNING OPEN- AND CLOSED-PATH SENSORS: SELF-HEATING, PRESSURE EFFECTS, AND TUBE WALL ADSORPTION	W.J. Massman
09:55-10:10	O44	CARBON SINK BY FOREST ECOSYSTEMS MAY BE OVERESTIMATED: ANALYSIS OF ONE-YEAR MEASUREMENT OF PRESSURE ITEM (Canceled)	J. Zhang
10:10-10:25		Discussion	

Oral Session IV: Global Biogeochemical Cycles — October 28 10:40-12:10

Chair: Nobuko Saigusa and Markus Reichstein

10:40-11:10	O51	*Invited*: NITROGEN DEPOSITION AND FOREST CARBON SINKS	J. Grace
11:10-11:25	O52	LONG-TERM OBSERVATION OF ATMOSPHERE-LAND EXCHANGE OF AMMONIA IN A JAPANESE PADDY FIELD	K. Hayashi
11:25-11:40	O53	SPATIAL PATTERNS FOR LEAF NITROGEN AND PHOSPHORUS STOICHIOMETRY OF TEMPERATE FOREST ECOSYSTEMS IN NORTHEASTERN CHINA	S. Ren
11:40-11:55	O54	CAN INTRA-ANNUAL STABLE ISOTOPE SIGNALS IN TREE-RING CELLULOSE BE USED TO EXTEND FLUXNET DATA-MODEL ANALYSIS TO LARGER TEMPORAL AND SPATIAL SCALES?	J. Ogée
11:55-12:10	O55	PHENOLOGY AND GROWTH OF DIFFERENT VEGETATION TYPES IN THE ENT DYNAMIC GLOBAL TERRESTRIAL ECOSYSTEM MODEL (DGTEM) EVALUATED AT FLUXNET SITES	Y. Kim

Oral Session V: Regular Session — October 28 13:30-15:00

Chair: Masahito Ueyama and Ke-Sheng Cheng

13:30-13:45	O61	CHARACTERISTICS OF HEAT, WATER VAPOR AND CO_2 FLUXES ABOVE A MOUNTAINOUS CRYPTOMERIA FOREST	C.I. Hsieh
13:45-14:00	O62	EXPLORING SOIL CO_2 FLUX OF TROPICAL FOREST IN THE 52-HA LAMBIR HILLS FOREST DYNAMICS PLOT	L.K. Kho
14:00-14:15	O63	ESTIMATION OF THE REGIONAL EVAPORATION WITH COMPLEMENTARY RELATIONSHIP AND CONVECTIVE BOUNDARY LAYER MODEL IN THE SOUTH OF LOESS PLATEAU, CHINA	Y. Iijima
14:15-14:30	O64	IMPACT OF TEMPORAL VARIATION OF kB^{-1} ON THE SIMULATION OF CARBON EXCHANGE IN A FOREST CANOPY	J. Hong
14:30-14:45	O65	DATA-MODEL FUSION FOR IMPROVING LAI MAPPING: A CASE STUDY OVER CHINA'S LANDMASS	M. Huang
14:45-15:00	O66	THE POTENTIAL OF CARBON SINK/SOURCE OF JAPANESE FOREST SOILS	N. Liang

Oral Session VI: Interfaces Between Carbon Science and Society — October 28 16:30-18:00

Chair: Joon Kim

16:30-16:45	O71	ASIAFLUX – SCIENCE COMMUNITY SUSTAINING ECOSYSTEMS AND PEOPLE THROUGH RESILIENCE THINKING	J. Kim
16:45-17:15	O72	*Invited:* CLIMATE CHANGE AND ACTIONS FOR A TRANSITION TO LOW-CARBON ECONOMIES	H. Hamanaka
17:15-17:45	O73	*Invited:* CARBON FLUX ASSOCIATED WITH LAND USE, MANAGEMENT AND DISTURBANCE ALONG AN URBAN TO RURAL GRADIENT	J. Hom
17:45-18:00		Synthesis & discussion	

October 27, 2009 (Tuesday)

Poster Session I — October 27 16:10-17:40

CarboEastAsia

P101 IMPACT OF METEOROLOGICAL ANOMALIES IN THE 2003 SUMMER ON GROSS PRIMARY PRODUCTIVITY IN EAST ASIA *N. Saigusa*

P102 REPRODUCING LONG TERM ECOSYSTEM CARBON BALANCE OF EAST SIBERIAN LARCH FOREST BY INTERPRETING BIOMASS, DENDROCHRONOLOGY, SOIL CARBON AND CLIMATE RECORDS *T. Machimura*

P103 SIMULATING CARBON BALANCE OF LARCH FORESTS IN EAST ASIA FROM STAND TO REGIONAL SCALE *M. Ueyama*

P104 Cancelled THE IMPROVEMENT OF PHENOLOGY MODULE FOR SUMMER GREEN TREE IN CLM3.5-DGVM USING MODIS LAI *Y.-H. Lee*

P105 ESTIMATING PARAMETERS IN AN TERRESTRIAL ECOSYSTEM MODEL WITH EDDY COVARIANCE FLUX MEASUREMENTS *L. Zhang*

P106 FOLIAR AND SOIL NATURAL ABUNDANCE OF ^{15}N PROVIDES FIELD EVIDENCE ON NITROGEN UPTAKE AND NITROGEN TRANSFORMATION IN TEMPERATE FOREST ECOSYSTEMS *H. Fang*

P107 PRECIPITATION PATTERN DRIVES INTERANNUAL VARIATION IN SOIL RESPIRATION IN A SUBTROPICAL CONIFEROUS PLANTATION *Y. Wang*

P108 DRIVERS OF NITROUS OXIDE FLUXES FROM THE SEMI-ARID STIPA GRANDIS GRASSLAND IN NNNER MONGOLIA, CHINA *X. Liu*

P109 SEASONAL VARIATIONS IN CARBON DIOXIDE EXCHANGE IN AN ALPINE WETLAND MEADOW ON THE QINGHAI-TIBETAN PLATEAU *L. Zhao*

P110 SIMULATION OF NET PRIMARY PRODUTIVITY AND EVAPOTRANSPIRATION IN EAST ASIA WITH THE REMOTE SENSING DRIVE BEPS MODEL CALIBRATED USING EDDY FLUX OBSERVATIONS *W.M. Ju*

P111 DEVELOPMENT OF EDDY FLUX DATA PROCESSING TECHNIQUE IN CHINA *H. He*

P112 INFLUENCE OF ASIAN MONSOON ON INTERANNUAL VARIABIITY OF NET ECOSYSTEM CARBON EXCHANGE IN TWO MAJOR PLANT FUNCTIONAL TYPES IN KOREA *H. Kwon*

P113 ESTIMATION OF SCALAR FLUXES USING AN AERODYNAMIC VARIANCE METHOD AT A CONIFEROUS FOREST IN GWANGNEUNG, KOREA *J. Yoo*

P114 COMPARISON OF RELATION BETWEEN TEMPERATURE, MOISTURE AND SOIL RESPIRATION IN SOME SITES *K. Tamai*

P115 DAILY GROSS PRIMARY PRODUCTIVITY AND EVAPOTRANSPIRATION USING SATELLITE REMOTE SENSING *S. Kang*

P116 EVALUATION OF SATELLITE DATA BASED VEGETATION ANOMALIES WITH ECOSYSTEM MODELS IN ASIA *K. Takahashi*

P117 ANALYSIS OF CLIMATE CONTROLLING FACTORS ON TERRESTRIAL GROSS PRIMARY PRODUCTIVITY: IMPLICATION FROM SATELLITE DATA AND ECOSYSTEM MODEL *E. Zigami*

P118 ASSESSMENT OF A TERRESTRIAL ECOSYSTEM MODEL USING FLUXNET OBSERVATIONS: TOWARD AN OBJECTIVE REFINEMENT PROCEDURE *T. Suzuki*

P119 ESTIMATION OF NET PRIMARY PRODUCTION IN BAMBOO ECOSYSTEM USING THE HARVEST METHOD *S. Goto*

P120 A SENSITIVITY ANALYSIS OF A TRIFFID-MOSES COUPLED DGVM TO BIOPHYSICAL CHARACTERISTICS IN A DECIDUOUS FOREST *J. Jang*

P121 ESTIMATION OF UNDERSTORY EVAPOTRANSPIRATION BY EDDY-COVARIANCE IN DECIDUOUS AND CONIFEROUS FORESTS *M. Kang*

P122 MEASUREMENT OF SOIL CO_2 EFLUX IN TEMPERATE DECIDUOS FOREST WITH AUTOMATIC OPEN/CLOSING CHAMBER SYSTEM *E. -H. Lee*

P123 CARBON DIOXIDE EXCHANGE AT FOUR GRASSLAND SITES ACROSS JAPAN AND INFLUENCE OF MANURE APPLICATION ON ECOSYSTEM CARBON BUDGET *R. Hirata*

P124 APPLICATION OF AUTOMATIC SLIDING CHAMBER FOR CONTINOUS MEASUREMERING NET ECOSYSTEM PRODUCTIVITY IN GRASSLAND ECOSYSTEM *J. Lee*

Bridges between Ecosystem Observation and Remote Sensing

P125 SOIL RESPIRATION IN NON-GROWING SEASON AND IT'S RESPONSE TO ENVIRONMENT FACTORS BASED IN A LOESS AGRO-ECOSYSTEM *R. -P. Li*

Cancelled

P126 CHARACTERISTICS OF CO_2 FLUX BEFORE AND IN THE HEATING PERIOD AT URBAN COMPLEX UNDERLYING SURFACE AREA *Q. -Y. Jia*

Cancelled

P127 THE OPTIMAL COLOR INDEX FOR THE PHENOLOGICAL RECORDING OF LEAF CANOPIES *T. Mizunuma*

P128 INFLUENCE OF THINNING ON MICROWAVE BACKSCATTERING USING THE AIRBORNE SYNTHETIC APERTURE RADAR AT A LARCH FOREST IN TOMAKOMAI, JAPAN *A. Takahashi*

P129 WET CANOPY EVAPOTRANSPIRATION IN A MOUNTAIN CLOUD FOREST *H.-S. Chu*

P130 INTEGRATED SYSTEM OF SATELLITE AND FIELD DATA FOR MAPPING OF GROSS PRIMARY PRODUCTION *A. Kamei*

P131 PHENOLOGY OF LEAF PHOTOSYNTHETIC PROPERTIES IN A COOL-TEMPERATE DECIDUOUS BROADLEAF FOREST IN TAKAYAMA, JAPAN *H. Noda*

P132 EFFECTS OF SEASONAL AND INTERANNUAL VARIATION IN LEAF PHOTOSYNTHESIS AND CANOPY LEAF AREA INDEX ON CANOPY PHOTOSYNTHESIS IN A COOL-TEMPERATE DECIDUOUS BROADLEAF FOREST IN TAKAYAMA, JAPAN *H. Muraoka*

P133 NEW METHOD FOR DETECTION OF VEGETATION PHENOLOGY WITH SATELLITE REMOTE SENSING: GRVI-METHOD *T. Motohka*

P134 ESTIMATION OF CARBON BUDGET OVER BLACK SPRUCE FORESTS IN THE NORTH AMERICA USING TERRA/MODIS DATA *Y. Ota*

P135 USE OF DIGITAL CAMERAS FOR OBSERVATION OF VEGETATION PHENOLOGY *R. Ide*

P136 EVALUATION OF MODIS EVAPOTRANSPIRATION ALGORITHM AT THE EAST ASIA *S. -T. Jung*

P137 MONITORING OF THE GROSS AND NET PRIMARY PRODUCTIVITY IN EAST ASIA USING THE MODIS IMAGERY *J. Lee*

P138 SPRING CANOPY PHENOLOGY OBSERVED BY PHENOLOGICAL EYES NETWORK (PEN) SYSTEM AT A DECIDUOUS BROADLEAF FOREST, KOREA *J. Choi*

P139 EVALUATION OF METHANE FLUX IN A TEMPERATE LARCH FOREST BASED ON THE FLUX MEASUREMENTS AND INVERSE METHOD *W. Nishimura*

P140 INTERSPECIFIC VARIATION IN EARLY SPRING SAP FLUX *J. Park*

P141 PARTITIONING SOIL RESPIRATION IN A RUBBER PLANTATION ECOSYTEM *D. Satakhun*

P142 THE CAFNET/COFFEE-FLUX PROJECT: EVALUATING WATER, SEDIMENT AND CARBON ECOSYSTEM SERVICES IN AN AGROFORESTRY COFFEE WATERSHED (COSTA RICA) *O. Roupsard*

P143 GEOGRAPHICAL AND YEAR-TO-YEAR VARIATIONS IN THE TIMING OF LEAF FLUSHING OF WINTER-DECIDUOUS FORESTS IN THE NORTHERN HEMISPHERE *M. Gamo*

P144 AN ANALYSIS OF LEAF PHENOLOGY USING A TIME SERIES OF FIXED VIEW CAMERA IMAGES - A CASE OF TROPICAL MONSOONAL EVERGREEN FOREST AT SAKAERAT, THAILAND - *T. Maeda*

Global Biogeochemical Cycles

P145 WATER VAPOR AND PRECIPITATION ISOTOPE RATIOS IN BEIJING, CHINA *X. Wen*

P146 ATMOSPHERIC NITROGEN DEPOSITION OF NSTEC FOREST ECOSYSTEM *W. Sheng*

P147 SEASONAL CONTRIBUTIONS OF CARBON DIOXIDE AND WATER FLUXES OVER A REED MARSH IN NORTHEAST CHINA *L. Zhou*

Cancelled

P148 DYNAMICS OF EVAPOTRANSPIRATION OVER GRASSLAND, MAIZE FARMLAND AND REED MARSH IN NORTHEAN CHINA AND ITS SIMULATION *G. Zhou*

Cancelled

P149 DEVELOPING AN INTEGRATED TERRESTRIAL MODEL OF VEGETATION DYNAMICS, ENERGY AND CARBON EXCHANGES AND BIOGEOCHEMICAL CYCYES IN COOL-TEMPERATE FOREST ECOSYSTEMS *M. Toda*

P150 SOIL CO_2 FLUXES IN SOUTHERN VIETNAM DURING DRY SEASON *J. Kurbatova*

P151 EFFECT OF LAND USE CHANGE ON SOIL CARBON DYNAMICS IN TROPICAL REGION *M. Adachi*

October 28, 2009 (Wednesday)

Poster Session II — October 28, 15:00-16:30

Barriers in Flux Measurements

P201 BIOMASS CARBON STOCKS AND ITS POTENTIAL IN RUBBER PLANTATION IN XISHUANGBANNA, SOUTHWEST CHINA *Q. -H. Song*

P202 THE CARBON BALANCE OF A PRIMARY TROPICAL SEASONAL RAIN FOREST *Z. -H. Tan*

P203 CARBON STORAGE AND SOIL CO_2 EFFLUX OF TROPICAL SEASONAL RAIN FOREST , RUBBER TREE PLANTATION AND PADDY SOIL IN XISHUANGBNANA, SOUTHWEST CHINA *L. Sha*

P204 A VALIDATION STUDY OF THE PRACTICAL CORRECTIONS FOR SENSOR HEATING AT OPEN-PATH IRGA SURFACES USING COMPUTATIONAL FLUID DYNAMICS *K. Ono*

P205 COMPARATIVE CO2-FILLING METHODS FOR EDDY COVARIANCE CARBON DIOXIDE FLUXES AT CHI-LAN MOUNTAIN FLUX TOWER SITE *C. -C. Wu*

Cancelled

P206 POOLING OF CO_2 AND ITS INMPLICATIONS ON NET ECOSYSTEM CARBON EXCHANGE MEASUREMENT IN A PRIMARY TROPICAL SEASONAL RAIN FOREST *Y. Zhang*

P207 NEW CO_2/H_2O GAS ANALYZER COMBINES THE ADVANTAGES OF OPEN-PATH AND CLOSED-PATH SOLUTIONS *G. Burba*

P208 OPEN-PATH EDDY COVARIANCE MEASUREMENTS OF METHANE FLUX *G. Burba*

Interfaces between Carbon Science and Society

P209 CARBON BUDGET OF TEMPERATE GRASSLAND IN CHINA AND ITS TREND IN THE FUTURE *X. Sui*

Cancelled

P210 SEASONAL CHANGES IN NET ECOSYSTEM EXCHANGE OF CO_2 AND RESPIRATION OF *CENCHRUS CILIARIS* L. GRASSLAND ECOSYSTEM IN SEMI-ARID TROPICS: AN EDDY COVARIANCE MEASUREMENT *C. Lalrammawia*

Cancelled

P211 CARBON DIOXIDE RESPIRATION CHARACTERISTICS WITH PHYSICOCHEMICAL PROPERTIES OF SOILS AT THE COASTAL ECOSYSTEM IN SUNCHEON BAY *P. -S. Kim*

Cancelled

P212 SPATIAL AND TEMPORAL PATTERNS OF SOIL RESPIRATION OVER THE JAPANESE ARCHIPELAGO: A MODEL-INTERCOMPARISON STUDY *A. Ito*

Regular Session

P213 CHANGES IN CARBON DIOXIDE SEASONS IN THE WARMER CLIMATE *G. Choi*

P214 MODELING SLASH PINE PLANTATION NPP BASED ON STEM-ANALYSIS DATA AND ALLOMETRIC EQUATIONS *X. Li*

P215 ESTIMATING LARIX FOREST BIOMASS OF 12 PROVINCES IN NORTH CHINA FROM FORESTRY INVENTORY DATA *Y. Liu*

P216 STEM RESPIRATION IN A SUBTROPICAL MONTANE CLOUD FOREST *S. -C. Chang*

P217 EVALUATIONS OF NIGHTTIME ECOSYSTEM RESPIRATION OVER A CHINESE PADDY FIELD USING TIME SERIES OF CO_2 DENSITIES AS WELL AS EDDY CORRELATION METHOD *H. Md. Shahadat*

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O11

THAIFLUX

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ThaiFlux is a network of flux observation sites in Thailand. The observation sites are located in natural forests, agro-forestry plantations and cultivated field crop plantations. ThaiFlux network has provided a valuable platform to promote collaboration and information exchange among Thai and international researchers. In October 2009, a training course on important scientific techniques related to flux studies will be organized by scientists studying rubber flux and this training course is expected to welcome a few ThaiFlux members and guest scientists. A local scientific meeting and workshop on flux studies are planned for 2010.

There are approximately 12.5 million hectare of forest in Thailand. Four observation sites have been set up to study carbon, water, and energy fluxes in major types of forest. **Kog-Ma** observation site, which is the oldest one, is located in hill evergreen forests which are wide spread throughout Southeast Asia mountainous area at elevation higher than 1,000 m. **Sakaerat** observation site, located in dry evergreen forest, aimed to study CO_2, water vapor and heat exchange. **Maeklong** observation site, located in the mixed deciduous forest, was established to study the meteorological and biological influence on CO_2 concentration and fluxes. Finally, **Ratchaburi** observation site is located in the 3rd generation dry dipterocarp forest.

Three observation sites were set up to study fluxes in economically important tree plantations. The first one is located in a teak (*Tectona grandis*) plantation in **Lampang** province. The initial objectives of this site were to observe and to model the hydrologic cycle and energy fluxes. There are two observation sites in rubber (*Hevea brasilensis*) plantations. The first one in **Chachoengsao** province was set up in 2006 and the second one in **Loei** province was recently set up in May 2009. The aims are to study carbon, water, and energy budget in rubber plantation ecosystem. Rubber plantation now covers more than 2.5 million hectares in Thailand and is one of the most important economic crops.

There are only three active observation sites in economically important field crops in Thailand. Two rice observation sites, one in rain-fed paddy field in **Sukhothai** province and the other in irrigated paddy field in **Pitsanulok** province, have been inactive and will soon be taken down. On the other hand, the number of observation sites in sugarcane plantation increased to two sites; one in **Burirum** province and the other in **Kanchanaburi** province. The main objective of these two sugarcane sites is to study water flux in order to estimate total water requirement for sugarcane production. The last observation site in field crop plantation is in a cassava field in **Nakorn Ratchasima** province. Cassava is an important cash crop for Thai farmers. Cassava planting area averages more than 1 million hectares in Thailand.

Finally, there is one observation site that monitors long term changes in CO_2, water vapor and energy fluxes due to land use change in **Tak** province.

All existing observation sites in Thailand were established through extensive international collaborations with many scientists from several Institutes, Agencies, and Universities, mainly from Japan, Korea, France, USA and New Zealand.

Oral

O12

PROGRESS OF FLUX MEASUREMENT OF FOREST ECOSYSTEM IN TAIWAN

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Tower Flux measurement of forest ecosystem in Taiwan started from 2005. Currently, there are five continuous operated flux sites (Table 1).Due to the steep slope and heterogeneous vegetation cover at most forest land in Taiwan, selection of ideal tower flux sites has been a difficult task. Lacking stable power supply, difficulty in accessibility, frequent rain and fog occurrence at most mountain forest area, and harsh field condition during Typhoon period pose additional limitations on the establishment as well as operation of the instrument laden tower flux sites.

The progresses of these five sites are various. Except the PTWL site, all other sites are located at mountain slope and the problem of topographic induced local airflow may further raise the problem of validation on measured fluxes. Currently, only the CLM site has established a quality flag procedure on flux measurements. The heavy foggy climate at this site seriously limits the operation of the open path CO2/H2O gas analyzer. It is only after the installation of a closed path CO2/H2O analyzer at 2007, the data capture rate has been acceptable. Nighttime data gap filling of the flux measurement, however, has not yet been determined due to the failure of the most common applied u* threshold filtering method. Preliminary analysis of the flow patterns at this steep slope (15 degree) site indicated that drainage flow might prevail below the forest canopy during the nighttime, and further studies are urgently needed to explore the local flow regime at CLM site. The accessibility of the NTY site has been a problem since its establishment and maintenance of continuous operation is not an easy task. The PTWL site is established at a newly established plantation converted from sugarcane field following a massive reforestation program. However, this young plantation consists of several native hardwood tree species planted in mosaic small patch. Distinct difference among plantation patches and physiological traits could lead to difficulty in interpretation of the measured flux. Sitou site is the newest flux site, and its logistic support might be the best among all existed sites in Taiwan. However, the effect of heavy tourist traffic as well as the patchy different age class forest stands on the flux measurement need to be carefully evaluated. Although the LHC is running smoothly partly because of the distinct wet-dry seasonal climate pattern and partly that it does not measure the CO2 flux. Although more flux measurements are needed in Taiwan, however, better instrumentation for constant wet climate and carefully evaluation of the topographic induced flow pattern at these already operated sites are urgently needed. In addition to that, plant physiological experiments and ground respiration measurement are also needed to start as soon as possible at most of these flux sites.

Table 1. General description of flux measurement sites in Taiwan.

Site Year started	Forest Type, Elevation	Management	Fluxes Measured
Chilan (CLM) 2005	Coniferous Plantation 1650 m	Yes	CO2, H2O, Sensible Heat
LienHuaChi (LHC) 2006	Evergreen Hardwood 770 m	No	H2O, Sensible Heat
N. TungYen (NTY) 2007	Evergreen Hardwood 2100 m	No	CO2, H2O, Sensible Heat
PingTung (PTWL) 2008	Hardwood Plantation 70 m	Yes	CO2, H2O, Sensible Heat
Sitou (ST) 2009	Coniferous Plantation 1250m	Yes	CO2, H2O, Sensible Heat

Oral

O13

Flux Measurements: Role in Emerging Climate Change Paradigm

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Abstract

Present changing Climate Change paradigm increasingly recognizes role of forests ecosystem in CO_2 mitigation. It necessitates empirical measurements of CO_2 emissions from forests along with biospheric observations of CO_2 fluxes between atmosphere and forest ecosystems. The newly recognized policy guideline of $REDD^+$ (Reducing Emissions from Deforestation and Degradation in Developing Countries), under Bali Action Plan of IPCC (Intergovernmental Panel on Climate Change), recognizes role of conservation, stabilization and Sustainable Management of Forests. $REDD^+$ enshrines financial incentives towards such carbon mitigation measures. Currently methodological tools for such measurements are being addressed for putting policy imperatives in practice.

The flux measurements are presently carried out through a global network of about 400 terrestrial flux sites. In India, ISRO (Indian Space Research Organization) is sphere heading the movement with a programme to bring different terrestrial forest ecosystems under observation. ICFRE (Indian Council of Forestry Research and Education), Dehradun in collaboration with University of Tuscia, Italy is also addressing flux measurements issue.

Synergy of ongoing flux measurements with empirical carbon emissions measurements under National Communications for emerging policy imperatives of REDD+ is a topical research need. Such linkages would not only address a critical data gap but would also provide flux community a platform in international policy arena affording financial, and infrastructural backstopping to the flux measurements.

O14

OZFLUX

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Each of the OzFlux sites listed below is or will be equipped with micro-meteorological instrumentation consisting of a sonic anemometer, an open path CO_2 and water vapor analyzer, a net radiometer, soil moisture and temperature sensors, and instruments to measure wind speed and direction, air temperature and humidity and the associated power and communications equipment.

1. *Tumbarumba Alpine Ash Forest– NSW: Operator CSIRO Marine and Atmospheric Research.* A super site designed as an 'outdoor laboratory' for micrometeorology, carbon and water cycles and emissions of aerosols and volatile organic compounds from highly productive wet sclerophyll eucalyptus forest.

2. *Poa Grassland, High Counry– NSW & Vic: Operator University of Sydney.* Water and carbon cycles of alpine grasslands in the upper reaches of the Murray River Catchment, a region particularly susceptible to bush-fires and climate change

3. *Wallaby Creek, Mountain Ash Forest – Vic: Operator Monash University.* Assess recovery of carbon and water cycles in the *Eucalyptus regnans* forests of the Wallaby Creek Catchment near Melbourne, destroyed by bushfires in February 2009 bushfires.

4. *Warra Long Term Ecological Research Site, Tasmania*: *Operator University of Tasmania.* Carbon and water cycles in an important wet schlerophyll forests in Tasmania for supporting forestry and nature conservation.

5. *Chowilla, Lower Murray Mallee – SA: Operator University. of Adelaide*. This site will be used to assess the impact of increased environmental water flows and other management interventions on health of Australia's major the river and riparian zone.

6. *Gnangara Mound, Coastal Heath – WA; Operator CSIRO Land and Water, Perth*. Site to examine water used by a managed coastal heath in the principal re-charge area for aquifers in the Perth Basin.

7. *Coolabah Arid Eucalyptus Region, Pilbara – WA: Operator University of Sydney*. Site to examine effects of mining activity on drawdown on regional aquifers in a region with changing climate.

8. *Alice Springs Region Mulga – NT: Operator, University of Technology Sydney*. Study carbon and water cycles of a site representative of a large area of arid rangelands in Australia.

9. *Northern Tropical Transect – NT: Operator, Charles Darwin University*. The transect in northern Australia crosses from wet tropical to arid rangelands. This will assess the impact of changing climatic regimes, fire impacts and grazing activity.

10. *Far North Queensland Tropical Rainforest – Qld: Operator James Cook University*. An important site for assessing health of native vegetation in an area of great biodiversity and which is important for nature conservation.

11. *South East Queensland Peri-Urban Grassland – Qld: Operator, Queensland University of Technology.* This site in peri-urban grassland will be used to assess the effects of rapidly growing urban population and infrastructure on the fragmented landscape and managed ecosystems.

O15

BRIEF INTRODUCTION AND FUTURE DIRECTIONS OF CHINAFLUX

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The eddy covariance technique has emerged as an important tool to direct measure carbon dioxide, water vapor and heat fluxes between the terrestrial ecosystem and the atmosphere after a long history of fundamental research and technological developments. The Chinese Terrestrial Ecosystem Flux Research Network (ChinaFLUX) relies on the Chinese Ecosystem Research Network (CERN) and was established in 2002, funded by the Knowledge Innovation Program of the Chinese Academy of Sciences (CAS) and the National Basic Research Development Project. The construction of ChinaFLUX refers to the criterion of most international flux networks, with uniform observation instruments, standardized measuring items and methods at each site. Up to now, ChinaFLUX includes 4 forest sites, 3 grassland sites, 1 cropland site and 1 swamp site with more than 60 site-years, and these eddy covariance sites present various climate and geographic types.

In the past seven years, ChinaFLUX has made significant progresses on the methodology and technique of eddy covariance flux measurement, on the responses of CO_2 and H_2O exchange between the terrestrial ecosystem and the atmosphere to environmental change, and on flux modeling development. Results showed that the major forests on the North-South Transect of Eastern China (NSTEC) were all carbon sinks during 2003 to 2005, and the alpine meadows on the Tibet Plateau were also small carbon sinks. However, the reserved natural grassland, *Leymus chinensis* steppe in Inner Mongolia, was a carbon source. On a regional scale, temperature and precipitation are the primary climatic factors that determined the carbon balance in major terrestrial ecosystems in China. Moreover, synthesis analysis indicated responses of GPP and ET to meteorological factors differed at the different forest types, which led to the coupling and decoupling between GPP and ET.

As a national research network, ChinaFLUX has promoted the development of flux research in China. By combining flux network and terrestrial transect, ChinaFLUX will develop integrated research with multi-scale, multi-process, multi-subject observations, placing emphasis on the mechanism and coupling relationships between water, carbon and nitrogen cycles in terrestrial ecosystems. A new National Basic Research Development Project will be launched at the next year, which aims to frontier fields of scientific research, and seek important scientific breakthrough based on previous research bases and large national scientific platform. This project will make effective uses of research sites from ChinaFLUX, and conduct comprehensive observations of carbon - nitrogen - water fluxes, multi-factors controlling experiments, and coupling model of carbon - nitrogen - water. Funded by this new project, original eddy covariance sites of ChinaFLUX will be promoted to the super sites with a series of compressive carbon, nitrogen and water fluxes observation system. Finally, several critical scientific questions will be derived based on super sites: 1) interannual variability of carbon, nitrogen and water fluxes in typical ecosystems and stoichiometric balance; 2) coupling mechanism of carbon, nitrogen and water cycles and environmental regulations; 3) development of integrated ecosystem model of carbon – nitrogen- water using multi-scale and source data; 4) temp-spatial patterns of carbon sink and source in China and East Asian and regional responses to climate change.

As an important part of FLUXNET, ChinaFLUX will play an important role in assessing the carbon budget on the Euro-Asian Continent and global ecosystems and in exploring the response and adaptation of terrestrial ecosystems to global changes. In order to study the terrestrial ecosystem carbon cycle, carbon budge and the interaction between carbon cycle and global change, ChinaFLUX should cooperate with not only the domestic organization of flux research, but also other national/regional fluxnet (AsiaFlux, KoFlux, AmeriFlux, CarboEurope, OzFlux).

O16

CURRENT ACTIVITIES OF JAPANFLUX

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JapanFlux is a network of scientists who belong to research groups that are involved in flux-related studies, including field-based measurement, ecosystem modeling, watershed hydrology or remote-sensing. At present, Japanese groups are operating about 25 flux sites in Japan and about 15 sites in other countries. Some sites are locally networked within individual ecosystems. In Japan, FFPRI FluxNet (http://www.ffpri.affrc.go.jp/labs/flux/aboutus_e.html) was organized with 6 forest sites, and 4 pasture sites are operated as a local network. Eight larch forests sites in Siberia, Mongolia, China and Japan were networked to investigate the role of larch ecosystems in global carbon/water cycles. Larch forest is the dominant terrestrial ecosystem in Northeast Asia. Also, in Southeast Asia, a tropical forest network was established with 11 towers in Thailand, Cambodia, Malaysia and Indonesia, which cover seasonal forest, rainforest and peat swamp forest.

JapanFlux promotes synthesis studies and model studies using field monitoring data. In an international research program “CarboEastAsia” with ChinaFlux and KoFlux, we are conducting such studies using network data sets. In addition, JapanFlux is going to collaborate with JaLTER (Japan Long Term Ecological Network), JAXA (Japan Aerospace Exploration Agency) and JAMSTEC (Japan Agency for Marine-Earth Science and Technology) in order to advance field research, remote-sensing technology and model improvement.

O17

KOFLUX REPORT 2009: IN RETROSPECT

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This presentation conveys KoFlux research efforts, activities, and results produced in 2009 to carry out the mission and vision of AisaFlux. To bring Asia's key ecosystems under observation, KoFlux has continued collaborative researches to measure and understand carbon, water, and energy exchanges over the major ecosystems in Korea. KoFlux has systemized a standardized data processing based on scrutiny of the data observed from these ecosystems to provide not only consistency in the processed data but also benefit to end-users. With the purpose of invigorating research collaborations on soil-vegetation-atmosphere interactions and promoting interdisciplinary studies in Korea, KoFlux hosted the 1st domestic expert workshop (as an *Agora*) on surface flux measurement and modeling during 10-12 June 2009 in Seoul, Korea. Furthermore, through collaborative efforts with other AsiaFlux members, KoFlux made it possible to publish a special issue entitled "Energy, Water, and Carbon Exchange at the Land-Atmosphere Interface" in Asia-Pacific Journal of Atmospheric Sciences. As a part of CarboEastAsia initiative, KoFlux is making progress in developing infrastructure for "Asian Carbon Tracking System (ACTS)" and the first report on "The Korean Carbon Budget" through a synthesized effort of measurement and modeling with various academic and institutional disciplines. The first special issue on CarboEastAsia program in Biogeosciences journal is currently in progress. In the years ahead, we expect even greater collaborations and the fruitful productions of ecosystem knowledge, service, and stewardship towards sustainability and human well-being.

Oral

O21
SYNTHESIS ACTIVITIES WITHIN FLUXNET: FROM POINT TO GLOBE

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The current FLUXNET database (www.fluxdata.org) of CO2, water and energy exchange between the terrestrial biosphere and the atmosphere contains almost 1000 site-years with data from more than 250 sites, encompassing all major biomes of the world and being processed in a standardized way(*1-3*). Here, we present results from the ongoing effort to synthesize the eddy covariance and ancillary data from the new standardized "La-Thuille" FLUXNET dataset. Three major topics will be addressed: 1) Attempts to quantify uncertainties of carbon and water fluxes across sites, 2) Identification of robust relations between fluxes and meteorological conditions, 3) Possibilities to empirically upscale flux quantities to the globe. Ad 1) we find that the heuristic and uncertain u*-correction introduces considerable uncertainties for carbon fluxes, which however remain below 120 gC m-2 yr-1 for the very most sites. Similarly day-time and night-time derived estimates of ecosystem respiration do differ depending on the site but are highly correlated. Key findings regarding point 2) include: 1) Gross primary production (GPP) and ecosystem respiration (TER) are strongly related, both temporally and spatially, 2) in most cases variability in net carbon flux (NEE) is more strongly related to GPP than to TER, but with notable exceptions, such as highly disturbed and low productivity systems, 3) water-carbon interactions are of critical importance and act via biophysical and ecophysiological feedbacks, 4) climate factors that are important at a short time-scale (e.g. diurnal or synoptic) may become irrelevant at longer time scales (e.g. inter-annual). For point 3) we show that the information in the data is sufficient to derive generalized empirical relationships between vegetation/respective remote sensing information, climate and the biosphere-atmosphere exchanges across global biomes. These empirical patterns are used to generate global grids of the respective fluxes and derived properties (e.g. radiation and water-use efficiencies or climate sensitivities in general, bowen-ratio, AET/PET ratio). For example we revisit global "text-book" numbers such as global Gross Primary Productivity (GPP) estimated since the 70's as ca. 120PgC(*4*), or global evapotranspiration (ET) estimated at 65000km^3/yr^{-1} (*5*)- for the first time with a more solid and direct empirical basis. Moreover climate factors such as radiation, temperature and water balance are identified as regionally varying driving factors for seasonal, inter-annual variations and trends of carbon and water fluxes.

Evaluation against independent data at regional to global scale (e.g. runoff data, landsurface modeling results) lends support to the validity of our almost purely empirical up-scaling approaches. Hence, these global fields and relationships of biosphere-atmosphere exchange should be used for evaluation or benchmarking of climate models or their land-surface components, while overcoming scale-issues with classical point-to-grid-cell comparisons.

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O22
AN ASSESSMENT OF THE REGIONAL SCALE CARBON UPTAKE CAPACITY BASED ON CATCHMENT WATER BUDGET AND ECOSYSTEM SCALE WATER USE EFFICIENCY

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As the world's major greenhouse gas emission countries, China, Japan and Korea initiated various cooperative activities to evaluate regional and continental scale carbon uptake capacity of the countries' terrestrial ecosystems as exemplified by the A3 CarboEastAsia program (http://www.carboeastasia.org). In relation to this pending scientific task, we proposed an approach using catchment water budget to estimate spatially averaged annual carbon budget. The method is based on a synthesis of hydrological and meteorological data to derive long-term steady state water budget for major drainage basins. The catchment scale annual transpiration (*T*) is an interim output from this practice. Together with *WUE* determined by an independent method, the derived *T* can be quantitatively converted to catchment scale annual carbon uptake such as Gross Primary Productivity (*GPP*). In doing so, deriving and understanding of ecosystem scale *WUE* and its variability (with time, climate conditions and vegetation types) become an additional challenge.

Synthesis studies of eddy covariance tower flux data in terms of *WUE* have been reported and enabled an enhanced understanding on both the magnitude and variability of ecosystem scale *WUE*. A marked difference was observed in *WUE* depending on vegetation types, although the effects associated with vegetation types and climatic conditions are often difficult to distinguish (e.g., Kuglitsch et al., 2008; Yu et al., 2008). While data for the annual variation in ecosystem *WUE* are relatively rare, results from the Gwangneung catchment in Korea indicated a variability of ~25% from 2006 to 2008. However, considerable uncertainties still exist as to the representative *WUE* for various vegetation types, and the extent and controlling factors of the annual variability in *WUE*. A cooperative study was proposed to derive *WUE* for diverse vegetation types in East Asia under the framework of CarboEastAsia program. As characteristic climate conditions in East Asia likely influence the coupling between carbon and water, we expect that the study will produce unique datasets of ecosystem scale *WUE* and, together with the water budget estimates, realize a better assessment of the carbon uptake capacity of the terrestrial ecosystems in the region.

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Oral

O23

PARTITIONING OF EVAPOTRANSPIRATION WITH A TWO-SOURCE MODEL: FROM SITE SCALE TO REGIONAL SCALE

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Quantifying the partitioning of evapotranspiration (ET) and its controls are particularly important for accurate prediction of the climatic response of ecosystem carbon, water, and energy budgets. We employed the Shuttleworth–Wallace model to partition ET into soil water evaporation (E) and vegetation transpiration (T) at four grassland ecosystems in China. The continuous measurements of ET with the eddy covariance technique were used to test the long-term performance of the model. Results indicated that the simulated ET at the four ecosystems was in good agreement with the measurements at both the diurnal and seasonal timescales, but the model tended to underestimate ET by 3–11% on rainy days. The monthly E/ET ranged from 12% to 56% in the peak growing seasons and the annual E/ET ranged from 51% to 67% across the four grassland ecosystems. Canopy stomatal conductance controlled E/ET at the diurnal timescale, and the variations and magnitude of leaf area index (LAI) explained most of the seasonal, annual, and site-to-site variations in E/ET. In addition, the variations in LAI could cause stronger effects on E/ET in the sparse-canopy ecosystems than in the dense-canopy ecosystems, implying that the hydrological processes and vegetation productivity for ecosystems in arid environments might be more vulnerable to projected climate change than those in humid environments.

Based on the good performance of S-W model at site scale, we modified it to make it suitable for regional applications. Main input variables of the new model is remote sensing products, e.g. LAI, NDVI, LSWI and some meteorological variables which are accessible from public databases. And also, in order to enhance our confidence on the model partitioning, we are conducting oxygen isotope measurements over a grassland ecosystem, through which the contribution of E and T could be quantified.

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MULTI MODEL AND DATA ANALYSIS OF TERRESTRIAL CARBON CYCLE IN MONSOON ASIA: FROM 2001 TO 2006

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Accurate monitoring and modeling of the current status and their causes of interannual variations in terrestrial carbon cycle are important. Recently, many studies analyze using multiple methods (e.g. satellite data and ecosystem models) to clarify the underlain mechanisms and recent trend since each single methodology contains its own biases. The multi-model and data ensemble approach is a powerful method to clarify the current status and their underlain mechanisms. So far, many studies using multiple sources of data and models are conducted in North America, Europe, Africa, Amazon, and Japan (e.g. Ichii et al., in press), however, studies in monsoon Asia are lacking. In this study, we analyzed the interannual variations in terrestrial carbon cycles in monsoon Asia to identify the patterns in interannual variability, their mechanisms, and current abilities of terrestrial ecosystem models.

We used multiple observation and ecosystem models which include eddy-covariance measurements, satellite-based observations, and terrestrial biosphere models to detect and analyze the anomalies of terrestrial carbon cycle (GPP/RE/NEE) from point to spatial scales. The ground observations are from AsiaFlux network which covers from Siberia to East and southeastern Asia. The satellite-based data include vegetation index data from multiple sensors such as NOAA/AVHRR, Terra/MODIS, SPOT/VGT, and SeaWifs. Terrestrial ecosystem models include Support Vector Machine regression, CASA, Biome-BGC and LPJ-DGVM and others. As a first step, we focused on the year 2001-2006. Anomalies from base period 2001-2006 were calculated in each data and model, and distinct characteristics and anomalies were extracted and analyzed.

The satellite observation and ecosystem models show clear characteristics in interannual variabilities in satellite-based NDVI and model-based GPP. These are characterized by (1) spring NDVI and modeled GPP anomalies related to temperature anomaly in mid and high latitudinal areas (positive anomalies in 2002 and 2005 and negative one in 2006), (2) NDVI and GPP anomalies in southeastern and central Asia related to precipitation (e.g. India from 2003-2006), and (3) summer NDVI and GPP anomalies in 2003 related to strong anomalies in solar radiations (e.g. Saigusa et al., in press). NDVI anomalies related to radiation ones (2003 summer) were not accurately captured by terrestrial ecosystem models (Fig. 3). For example, LPJ model rather shows GPP positive anomalies in Far East Asia regions probably caused by positive precipitation anomalies. Further analysis requires improvement of models to reproduce more consistent spatial patterns in NDVI anomaly, and longer term analysis (e.g. after 1982).

References

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O31
"J-INTER-COMMUNITY" FOR ECOSYSTEM STUDY BINDING FIELD WORK, MODEL, AND REMOTE-SENSING

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The interaction between environment and ecosystem is so complicated that we need combination of various different approaches for understanding it. Roughly speaking, the useful approaches are categorized into three categories: field study, numerical model, and remote sensing. Each category of these research methodology requires tremendous expertise and human/financial/instrumental resources, so that a small research team cannot afford all. However, now that each methodology has matured communities (or organizations) specializing it, it should be useful and fun for such communities to join together and work together. Thereby some Japanese communities and organizations have decided to make a group (inter-community) for integrated study of ecosystems. The community, so called "J-Inter-Community" (not an authorized name yet), consists of JapanFlux, JaLTER, JAMSTEC, and JAXA. JapanFlux covers flux study. JaLTER covers long-term ecology field works. JAMSTEC makes integrated model study. JAXA operates remote-sensing study with its own satellites. Each of the four communities and organizations has its own counterparts in the world, hence this group aims to propose not "Japan-only" but internationally scalable framework for ecosystem study. As a first step, we started a joint-research project for algorithm development for a future satellite "GCOM-C" to be launched in 2014 by JAXA. Through this activity, we should refine and integrate the observation protocols, database, data policies, education/training contents among us.

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ESTABLISHMENT OF BASELINE OF CARBON STOCK AND FLUXES ON TROPICAL PEATSWAMP FOREST AREA IN KAMPAR PENINSULA, RIAU, INDONESIA

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This research activity has been conducted to prepare baseline required for understanding and upscaling carbon cycling to support sustainable landscape management of one amongst largest tropical peatland areas in Kampar Peninsula (700,000 ha) in Riau province which totally composed of about 4 million deep peatland. Due to rapid peatland utilization for economic activities, those peatland has switched from previously very efficient carbon sequestering into a massive carbon emittor system and among significant global emission hot-spot, largely due to peatland drainage and human-related fire during land preparation. The activities covered here are : (i) summarizing existing knowledge and development of carbon accounting and monitoring system, (ii) valuation of different land uses and land management of the forest peatland including its management impacts on livelihood and on forest ecosystem services (biodiversity, water, fire, livelihood) and (iii) summarize best management options on land uses and management of peatland that could satisfy both socio-economics and ecosystem demands.

Owing to deep peatland, most carbon are stored in peat. Accounting of these carbon stock at landscape level has been conducted by manual peat coring (160 points), geophysical measurement (using geo-electric-50 lines) and modelling of combined radar-generated and terrestrail measurement of topography. Calibration of peat depth using non-destructive approach (geo-electric) showing that the calibration was good (r=0.96), therefore in the future peat depth could be determined without manual coring (which is time and labor less-consuming). Applying this method, it is possible to do extensive ground measurement for up-scaling peat (and carbon stored on peat) volume at landscape level. Data on topography (low resolution radar-SRTM and interferometry derived from high resolution radar imageries ie. ALOS PALSAR and TerraSar-X callibrated with the terrestrial measurement (using levelling and GPS-differential) will be used for improving the model of peat volume estimation, in near future.

Peat characterization is conducted for each layer of 50 cm incremental depth sampled during the peat coring. Bulk-density, maturation stage and carbon content for each layer were determined. Fourier-transformed infre-red (FTIR) spectroscopy is used for chemical characteristization. Age of peat layer for the selected location will be determined for estimating peat formation rate.

CO_2 emission measurement has been conducted using closed-chamber connected with infra-red gas analyzer (IRGA) on 70 different spot/compartment (with 9 replications each). For each spot, standard of error (SE) values for each 9 measurements per spot/compartment were mostly less than 10%. To quantify carbon lost due to peat decomposition, only heterotrophic respiratory sources were considered, through subtraction of total CO_2 flux measured for those in (open area) peatland with no-vegetation. In contrast to strong water-control, temperature control on peatland respiration was very low. Vegetation (roots) contributed more than 60% CO_2 flux and this proportional autotrophic contribution was correlated with the plantation (*Acacia crassicarpa*) age. Five water-table and temperature dataloggers were installed in several locations to incorporate temporal variability aspect during the upscaling of the flux.

Peat subsidence is proposed to be a proxy value of carbon lost from peat at landscape level. To proof this hypothesis, the accuracy of the subsidence measurement should be within sub-cm. We have installed 8 subsidence monitoring points for further ground callibration of the subsidence. This terrestrial measurement using differential-GPS measurement will be combined with differential interferometry synthetic apperture radar (DInSAR) to quantify peat subsidence at annual basis. The radar imageries (ALOS PALSAR and TerraSAR-X) will be used for measuring carbon emission using this remote-sensing approach.

Forest inventory was conducted in parallel with ground-truthing of the remotely-sensed imageries (against ALOS PALSAR and SPOT imageries) of 102 point in across the peninsula, whose each spot (@ 0,4 ha): the individual tree diameter, species composition , leaf area index (LAI) and individual canopy projection was determined. These ground-truthed data were used to callibrate remotely sensed imageries in order to upscale carbon stock in above ground biomass at landscape level. Biomass lost due to forest conversion were calculated from processing of the time-series imageries.

We have established permanent sample plots (PSPs) of the natural forests aimed at the observation of forest stand dynamics on peatland. Two of each one hectare plots were established to represent shallow (3 m) and deep peat (10 m), which all the present tree that are higher than 10 cm was tagged, the baseline diameter was measured and the taxonomy was characterized. Wood sample were taken using increamental borer for measuring wood density and inspection of possible presence of tree ring for further dendrochronological studies. Herbarium materials were brought to the Yogyakarta laboratory for further taxonomical study. The result of the observations will be used as an inputs for prediction of the environmental changes (type of changes, rate of changes, and the magnitude of the impacts) on the stand dynamics. Further, this information can become the basis of the strategy formulation for the changes management. In the future, the series data from permanent plots will be used to validate carbon sequestration potential of peat forest. The validation will apply process-based approach as the environmental parameters and growth patterns will be measured periodically. The observation in the permanent will also provide information on impacts of climate change to biodiversity, growth and implications carbon cycling; integrating processes at plot into landscape level.

Oral

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MODELING ENERGY AND WATER FLUXES OVER INDIAN AGROECOSYSTEMS – BRIDGING GAP FROM CANOPY TO REGIONAL SCALES WITH SATELLITE BASED THERMAL REMOTE SENSING

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The mechanism of biosphere-atmosphere responses and feedbacks is controlled by physical and physiological processes through soil-plant-atmosphere-continuum. The modeling approaches using soil-vegetation-atmosphere-transfer (SVAT) schemes simulate coupled transport of energy (radiative and convective), water (evapotranspiration) and carbon (net assimilation) that provides insight into surface processes across a variety of climate, soil and vegetation types. The implementation of detailed SVAT models at landscape and regional scales suffers from obtaining reliable parameter fields over large areas. A critical surface energy balance (SEB) component (e.g. sensible heat flux) from SVAT (e.g. ALEX) simulation was compared with a satellite (e.g. MODIS) based approach (e.g. METRIC) using remotely sensed land surface temperature (LST) over a semi-arid irrigated agricultural (e.g. wheat) landscape ($1km^2$) in northwestern India. This showed less accuracy of the former (root mean square error, RMSE = 30 Wm^{-2}, 35%) than the latter (RMSE = 21 Wm^{-2}, 11.5%) with respect to area averaged measurements from LAS (Large Aperture Scintillometer). The two-dimensional (2D) scatters between LST and vegetation index proved to be worth to develop a soil wetness index to extract surface soil moisture in cropped soils at field scale (90 m) with ASTER (RMSE = 0.039 m^3m^{-3}) as well as at landscape scale with MODIS data (RMSE = 0.033 m^3m^{-3}). These studies confirm the practical utility of satellite based thermal remote sensing for modeling land (soil-canopy complex) surface fluxes and soil moisture at spatial domain. Further, a simplified evaporative fraction (Λ) based single-source SEB was implemented for the first time over Indian landmass to determine regional energy and water fluxes in clear skies at 0.08° grid validated during a growing (November to March) season. The core radiation variables such as insolation, LST, surface albedo and air temperature were retrieved using noon-midnight thermal remote sensing data, combined with broad optical band data at noontime, acquired from Indian geostationary meteorological satellite sensor, Kalpana-1 VHRR (hereafter K1VHRR). These variables were further used to determine net available energy (Q) which is the difference between net radiation and soil heat flux. LST-albedo 2D scatters from noontime data were exploited to scale Λ between 0 and 1. The combination of Q and constant-Λ hypothesis resulted into latent heat fluxes (λE). The validation envisages a two-step approach. In step 1, the landscape scale (0.01°) energy and water fluxes from MODIS AQUA were validated over 2 km x 2 km homogeneous patches within five diverse large (10 km x 10 km) agricultural landuses against *in situ* measurements on selected clear sky days with portable automated systems. In step 2, the MODIS outputs were aggregated to validate coarser scale outputs from K1VHRR. These showed 18% root mean square deviation (RMSD) in daytime Q and Λ, and 26% RMSD in λE from K1VHRR. Regional validation of K1VHRR eight-day evapotranspiration (ET) fluxes from wall-to-wall comparison with aggregated landscape ET estimates yielded a correlation coefficient (r) of 0.80 from 52853 paired datasets over Indian agricultural landuses with 26% RMSD. An indigenous micrometeorological data collection system with uplinking facility through INSAT satellite communication transponder has been defined and evaluated for diurnal measurements of radiation, energy and water fluxes. The half-an-hourly coverage from the future (first-half of 2010) Indian geostationary satellite, INSAT 3D, with 4 km split-thermal imaging and 10 km sounding bands, and continuous *in situ* flux data from the expanding network of micromet towers over a variety of vegetation types would widen the modeling scope of large-scale land-atmosphere exchange processes over the Asia continent.
(Key words: *land surface processes, energy and water balance, satellite remote sensing*)

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SPATIAL-TEMPORAL VARIATIONS AND ENVIRONMENTAL CONTROL FACTORS OF ECOSYSTEM LIGHT USE EFFICIENCY AMONG TYPICAL FORESTS IN EAST ASIA

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Light Use Efficiency（LUE）is widely used for scaling land-air carbon fluxes and studying vegetation photosynthesis effectiveness on leaf or species scales. However, the variation and environmental controls on ecological LUE of forests remain poorly documented, especially in East Asia region. Therefore, eight typical forests in East Asia were adopted here for analyzing spatio-temporal variation of the ecological LUE. Nineteen site-year daily carbon fluxes and metrological data, which were required from eddy covariance towers, were related to calculate ecological LUE.

Generally, daily ecological LUE in East Asia forests were between 0.3 ~ 1.0 gC/molPhoton (about 1.4 ~ 4.6 gC/MJ PAR), while monthly and annual LUE spans 0.4 ~ 0.7 and 0.05 ~ 0.35 gC/molPhoton respectively, indicating the variation range of LUE became much less over longer studying periods.

Furthermore, annual ecological LUE of East Asia forests were negatively correlated to latitude（LUEannual = -0.0044 * Latitude + 0.3357，R2=0.39, n=19）. The maximal annual LUE were mostly found in the tropical evergreen forests (about 0.31±0.01 gC/molPhoton) while minimal ones appeared in the sub-arctic needle-leaf forests (0.05±0.01 gC/molPhoton).

In addition, the main biological control of LUE was Gross Primary Productivity (GPP), which explaining 80% of LUE variation. In comparison, Photosynthetically Active Radiation (PAR) only explained for 15%. On annual scale, mean air temperature was the primary environmental control on LUE rather than water vapor pressure deficiency in East Asia region. The resultant spatio-temporal variation and bio-environmental controls of ecological LUE in East Asia might improve our understanding on forest carbon cycle and propel further effort on regional biogeochemical modeling.

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RELATIONS OF SPRINGTIME CANOPY DEVELOPMENT WITH CARBON AND WATER FLUXES IN A DECIDUOUS BROADLEAF FOREST

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Ecosystem carbon and water fluxes shows dramatic changes during spring canopy onset period. It has been considered that canopy phenology is strongly coupled with ecosystem carbon and water phenology (i.e. seasonal variations of vegetation productivity and evapotranspiration). However, field evidences are not enough to derive general conclusion on the relations, especially during canopy onset period. This is partly because there is big uncertainty in defining and detecting the timing of canopy phenological onset. As well, scale mismatches in measuring carbon and water fluxes and canopy phenology makes it hard to relate those because each measurement potentially sees different places. Hence, comparing divers measurements from single leaf to footprint area of flux tower through individual tree level can provide a new insight to link leaf and canopy–level phenological changes with single tree and footprint scale fluxes of carbon and water.

In this study, we explored relations of springtime canopy development with carbon and water fluxes measured at individual tree level and footprint scale of flux tower in a deciduous broadleaf forest, Gwangneung flux tower site from March to June in 2009. The canopy development was observed by using five different methods: naked eye observation, light intensity logger, digital camera, in-situ spectrometer, and satellite remote sensing. In addition, we collected carbon and water flux data at a footprint and individual tree levels from eddy-covariance flux tower measures and sapflow measurement system, respectively. Those include net ecosystem exchange of carbon (NEE) and evapotranspiration from flux tower and mean sapflow density and stand transpiration from sapflow measurement system. The light intensity data detects change of light attenuation by canopy, while digital camera image detects change of canopy color and provides spectral information of blue, green, and red bands reflected from canopy. Field spectrometer and satellite multi-spectral image (MODIS) were utilized to provide vegetation indices relevant with canopy development at fairly different spatial scales. The sapflow rate was measured from 6 overstory trees of two dominant species. Our preliminary analysis shows considerable complexity and uncertainty to combine the diverse measurements to explain springtime ecosystem changes of canopy and productivity and evapotranspiration.

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NET PRIMARY PRODUCTION OF TROPICAL RAIN FOREST USING GLOBAL PRODUCTION EFFICIENCY MODEL AND ASTER SATELLITE DATA

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Rapid development in industrialisation, urbanisation and agricultural sectors have contributed to an increased in green house gases in the atmosphere, particularly carbon dioxide (CO_2). An increased in CO_2 concentration in the atmosphere is considered as one of the main factors that caused the phenomena of global warming and climate change. Thus, knowledge pertaining the existence, concentration and losses of CO_2 in the atmosphere are very important. This is very useful for ensuring the concentrations of CO_2 in the atmosphere remain in the state of balance. One of the ways to monitor the content of CO_2 in the atmosphere is through the measurement of the rate of absorptions of CO_2 by vegetation. This can be carried out either by determining the biomass or the Net Primary Production (NPP) of the vegetation. The main objective of this study is to evaluate the Global Production Efficiency Model (GLOPEM) that is one of the models used to determine NPP using remote sensing data. ASTER satellite data with the spatial resolution of 15 meter and the spectral range of 0.52 μm of 0.86 μm were used in this study. The evaluation GLOPEM's model is based on the accuracy of the measured NPP values for three types of vegetation such as forest, oil palm and rubber in the vicinity of Pasoh Forest Reserve in Negeri Sembilan. An assessment was made by determining the Coefficient of Variation (CV) to calculate error and also through comparison with results from previous studies. This study showed that GLOPEM's model gives the highest accuracy of NPP for forest and rubber with CV of 4.7% and 3.0% respectively and gives the lowest accuracy of oil palm NPP which CV of 41.98%. As a whole, the range of NPP obtained for forest, oil palm and rubber are within the range of 697.33 gCm^{-2} yr^{-1} to 3065.85 gCm^{-2} yr^{-1} with average values of 2509.79 gCm^{-2} yr^{-1}. While average values of NPP for forest, oil palm and rubber is 2812.5gCm^{-2} yr^{-1}, 2852.9gCm^{-2} yr^{-1} and 2864.6gCm^{-2} yr^{-1} respectively.

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KEEPING AN EYE ON THE CARBON BALANCE: LINKING CANOPY DEVELOPMENT AND NET ECOSYSTEM EXCHANGE USING AN INTERNATIONAL WEBCAM NETWORK.

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Phenological events such as the spring leaf-out and the autumn fall exert a strong control on both spatial and temporal patterns of the carbon and water cycle. As these life cycle events are strongly influenced by changes in weather patterns from year to year, phenology is deemed a robust integrator of the effects of climate change on natural systems. It is now recognised that improved monitoring of phenology on local-to-continental scales is now needed. At FLUXNET sites around the world overlooking forests, pastures, and wetlands, we have identified an opportunity to establish precision measurements of phenological events by simply mounting networked digital cameras ('webcams') and recording daily (or even hourly) images of the vegetation canopy. A recent FLUXNET survey has identified several phenocam networks already 'keeping an eye' on canopy development whilst simultaneously monitoring carbon and water exchange between the forest and the atmosphere. Although this network is in its infancy, it appears to be growing steadily. Here we present the efforts of this growing, international phenocam network and illustrate with examples taken from the network some of the key uncertainties that can now be tackled using this multi-technique approach. The opportunity presented to us is clear: webcam measurements at FLUXNET sites will reveal the link between phenology and carbon uptake and provide much-needed ground verification of phenology products derived from satellite remote sensing (e.g., MODIS). This multi-scale monitoring of phenology and net ecosystem exchange of CO_2 will enrich our understanding and efforts at modelling not only the impacts of climate on phenology but also the impact of phenology on climate through feedbacks on the carbon and energy cycle of the planet.

O41
INSTRUMENT SURFACE HEAT EXCHANGE AND OPEN-PATH CO_2 FLUX

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Open-path gas analyzers are useful, low-maintenance, stable instruments, with excellent frequency response and low power demands, which make them ideal for long-term studies at remote sites. By the nature of their design, open-path instruments are also *open*, and cannot be protected with a cover or a filter from outside influences, especially in case of large amounts of dust, water, and ice, and as shown recently, heat.

Ordinarily, ambient sensible heat flux effects are corrected in open-path analyzers by a well-established Webb-Pearman-Leuning term (Webb et al., 1980) also correcting for latent heat flux effects. The sensible heat flux portion of WPL term is significant for fluxes measured with open-path analyzers, because temperature fluctuations are not attenuated in long intake tubes, as it is done in closed-path analyzers. Recently, experimental evidence suggested that small amounts of heat generated by the instrument surface surrounding the open cell are not always negligible in cold situations, when background CO_2 and heat fluxes are also small. For such situations, the heat generated by instrument surfaces into the open cell may need to be included into the sensible heat portion of the WPL term, as an adjustment.

For the case of the LI-7500, such adjustment would typically be below 0.025 mg, or 0.6 μmol, of CO_2 m^{-2} s^{-1} which is about an order of magnitude smaller than WPL correction, and similar in magnitude to frequency response corrections. In spite of the small size of the effect, it may be a cause of small apparent CO_2 uptakes observed in a few recent reports when no such uptake was expected. Apparent uptakes were observed most significantly when air temperatures were quite low, e.g. -10°C, or less (Amiro, *et al*., 2006; Lafleur and Humphreys, 2008; Jarvi, et al., 2009), becoming small at milder temperatures during the off-season (Hirata *et al.* 2005; Grelle and Burba, 2007; Burba, *et al*., 2008; Ono, *et al*., 2008), yet they have not been observed during the growing season even in cool northern or alpine environments (Amiro, *et al.,* 2006, Haslwanter, *et al*., 2008).

On the other hand, a number of studies have been published showing excellent agreement between eddy covariance flux measurements made with the LI-7500 and closed path instruments (Billesbach *et al*., 2001; Miller, *et al*., 2004; Launiainen *et a*l., 2005; Morgenstern, *et al*., 2006; Hirata *et al*., 2007; Haslwanter, *et al*., 2008; Clement, *et al*., 2009), and other work has confirmed the accuracy of the corrections proposed by Webb, *et al.* (1980) that are needed to account for air expansion and water vapor dilution due to sensible and latent heat fluxes (Leuning*, et al*., 1982; Ham and Heilman, 2003).

It is, therefore, important not to arbitrarily discount small uptakes during filtering and quality control, and to try to verify or disprove such observations by the adjustment or an alternative approaches. The adjusted flux can be computed using a fine wire thermometer to directly measure sensible heat in the open-path (Grelle and Burba, 2007). The adjustment can also be applied to previously collected CO_2 flux data using an approach developed from the comparison of flux measurements made with open-path and closed-path instruments at a specific site (Jarvi *et al*., 2009), or by using semi-empirical methods based on standard weather variables (Burba, *et al*., 2008). Adjustments are not necessary for data collected during the growing season, yet they will not significantly affect results if applied. The current physical and mathematical descriptions of the surface heating adjustments should be considered preliminary and will benefit from further research.

At LI-COR, we take measurement accuracy seriously. Since focusing our efforts on the heating effect in last few years, we have made significant scientific and engineering progress, and worked closely with the flux research community to understand and quantify the effect, and to make the community aware of it. We have also addressed it instrumentally. Since 2005, we have developed a new enclosed low-power CO_2/H_2O gas analyzer (LI-7200) not affected by the surface heating; a new open-path CH_4 gas analyzer (LI-7700) in which the surface heating effects were not observed even when >1000 Wm^{-2} of artificial heat was provided via mirror heaters; and have modified the LI-7500 to reduce the surface heat exchange in cold environments (LI-7500A).

Oral

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EDDY COVARIANCE MEASUREMENTS OVER A PASTURE: COMPARISON OF OPEN-AND CLOSED-PATH GAS ANALYSERS AND THE ENERGY BALANCE CLOSURE PROBLEM

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Measuring CO_2 and H_2O fluxes at the Otway site in south-western Victoria has proven more difficult than originally anticipated. While the site is ideal from a micrometeorological point of view, with upwind fetches 500 – 600 m over pasture allowing measurements to be made at 4.5 m above ground, there is a large loss of flux data due to mist and rain on the LiCor 7500 open-path CO_2 and H_2O vapour analyser. In an attempt to solve this problem, we have converted an open-path instrument into a closed-path one, significantly reducing the periods of data loss due to rain. The new setup has its own problems in measuring H_2O fluxes due to adsorption/desorption of water vapour on the walls of the sampling tubing. The presentation will examine the strengths and weaknesses of using open- and closed-path analysers in terms of Webb, Pearman & Leuning theory, spectral and co-spectral analyses and lag-correlation analysis. The issue of energy balance closure ($H + \lambda E$ vs $R_n - G_0$) will also be discussed.

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THREE ISSUES CONCERNING OPEN- AND CLOSED-PATH SENSORS: SELF-HEATING, PRESSURE EFFECTS, AND TUBE WALL ADSORPTION

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Biologically active surfaces (or ecosystems) exchange CO_2, water vapor, and other trace gases with the atmosphere. But quantifying these exchange fluxes by eddy covariance is complicated because present-day trace gas sensors measure total mass transport by counting the number of molecules that pass through a detector. Consequently, to determine the surface exchange fluxes mass fluxes measured by eddy covariance require additional terms to account for dynamically and thermodynamically driven atmospheric processes. This adjustment takes the form of variations in the ambient temperature, moisture, and pressure fields [the Webb-Pearman-Leuning (WPL) terms of the basic 3-dimensional conservation equation of eddy covariance]. Since the genesis of these additional effects arise from mixing processes imbedded in the environment surrounding the trace gas sensor, the application of the WPL terms is different for open- and closed-path eddy covariance systems. Closed-path systems are normally thought to be free of temperature effects due to heat exchange with the tube walls, whereas they are critical to open-path systems. But either measurement system will be affected by heat generated by a heat source near the detector (e.g., self-heating). Furthermore, fluxes measured by either system can be affected by pressure fluctuations. This will become more pronounced the more turbulent the atmosphere or with the addition of any extraneous pressure fluctuations in the detector's sensing path. At the GLEES AmeriFlux site [located in the Snowy Range Mountains of the Medicine Bow National Forest, southeastern Wyoming (41°21'52" N, 106°14'22" W; 3190 m MSL)], which employs an open-path system, the effects of instrument self-heating and pressure are both important. Combined, these effects reduce the annual NEE estimates by a factor of two, but have very little impact on annual ET loss. The impact on NEE estimates is important in its own right, but as the GLEES site is presently in its third year (at least) of a major beetle epidemic quantifying this is crucial to documenting the effects of this disturbance on the ecosystem's carbon and water budgets. Closed-path systems are less prone (but not immune) to these two sources of error, but fluxes obtained by such systems are subject to distortion due to mass and heat exchange at the tube walls. This is of particular significance for water vapor and therefore for isotopes of water vapor that are measured with closed-path systems. This presentation closes with a brief discussion of the need for (and progress toward) physically-based models to understand and predict these wall effects.

Oral

O44

CARBON SINK BY FOREST ECOSYSTEMS MAY BE OVERESTIMATED: ANALYSIS OF ONE-YEAR MEASUREMENT OF PRESSURE ITEM

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It's well known that pressure fluctuations are extremely important in the budgets of turbulent kinetic and shear stress (McBean and Elliott, 1975; Wilczak et al., 1999). Short term measurements show that the magnitude of pressure fluctuations increase with increasing wind velocity (McBean and Elliott, 1975; Sigmon et al., 1983; Wilczak et al., 1999). And pressure flux may contributes significantly to the WPL term for CO_2 or any other trace gas (Massman and Lee, 2002; Zhang et al.,2006ab).

For $\overline{w' p_a'} \le 0$, the nighttime flux will be underestimated, and the daytime flux will be overestimated without the consideration of pressure-induced flux. However, high frequency pressure variation measurements are not available in most station and few studies on static pressure over roughness surface were carried out. Using eddy-covariance method, measurement of $\overline{w' p_a'}$ over a mixed forest canopy was carried form May 2007 to June 2008. Primary analysis shows that the pressure item contributes about 50gC m^{-2} yr^{-1} to -230gC m^{-2}, the annual NEE. On the model developed using this measurement, present carbon sink of global forest ecosystems was overestimated by 15% without the including of the pressure item.

O51

NITROGEN DEPOSITION AND FOREST CARBON SINKS

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Reactive forms of nitrogen (NH_x, NO_x) have accumulated in the Earth's atmosphere as a result of emissions from agricultural systems, transportation and industry. These compounds are transferred to ecosystems by wet and dry deposition. As plant growth in much of the world is rate-limited by the supply of nitrogen, the deposition of nitrogen from anthropogenic sources is likely to perturb ecosystems (Reay *et al.* 2008). At high levels of deposition this may lead to undesirable effects, but lower levels are likely to stimulate many ecosystems into higher productivity, and therefore intensify the regional and global forest carbon sinks. We review the evidence for sink-stimulation by active nitrogen (eg Magnani *et al.* 2007), and consider possible mechanisms. We contrast these observations with claims that current levels of deposition have a damaging effect on the structure and biodiversity of ecosystems. We also propose large-scale experimental approaches, involving eddy covariance measurements, aimed towards defining the global extent of sink-stimulation.

Magnani F, et al. (2007). The human footprint in the carbon cycle of temperate and boreal forests. *Nature* 447, 848-850.

Reay, DS, Dentener F, Smith P, Grace J and Feeley RA (2008) Global nitrogen deposition and carbon sinks *Nature Geoscience* doi:10.1038/ngeo230

Oral

O52
LONG-TERM OBSERVATION OF ATMOSPHERE-LAND EXCHANGE OF AMMONIA IN A JAPANESE PADDY FIELD

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This study aims to elucidate the atmosphere-land exchange of ammonia (NH_3) at a paddy field in central Japan. Measurement of NH_3 exchange started in the mid May, 2007, and is going on at present. Main management practices by the farmer are as follows: late Apr., basal fertilization of chemical fertilizer with a rate of ca. 60 kg N ha^{-1} and submergence; early May, transplanting of rice seedlings; mid to late Jun., mid-summer drainage; early summer, supplemental fertilization with a rate of ca. 10 kg N ha^{-1} as necessary; mid Aug., final drainage; early Sep., harvesting; to next spring, fallow period. Poultry manure was applied to adjacent paddy fields in Feb. 2008; application of manure is conducted in winter once per several years. Weekly means of atmospheric NH_3 concentration were measured using passive samplers installed at heights of 1.5 and 4.0 m from the ground surface (n = 4 per height). 30 min-means of diffusion velocity were derived from micrometeorological measurements. Weekly exchange flux of NH_3 was determined as the product of the difference in concentration at the two heights by the weekly-averaged diffusion velocity. Continuous measurements of NH_3 concentrations at the two heights were additionally and occasionally conducted using an NH_3 monitor (AiRRmonia, Mechatronics).

Ammonia concentrations showed a range of 0.8-4 ppb excluding Feb. 2008 with a maximum value of 15 ppb, when poultry manure was applied (Fig. 1). The concentrations at 4.0 m were higher than those at 1.5 m in most cases, which indicated the predominance of NH_3 dry deposition at the paddy field. The application of poultry manure in Feb. 2008 resulted in a temporal and strong emission of NH_3. Weak NH_3 emissions also took place in early summer when supplemental fertilizations were conducted by surface broadcast. The cumulative fluxes from May 2007 to Mar. 2008 were 4.7 and 5.7 kg N ha^{-1} as deposition and emission, respectively. It was concluded that the paddy field was essentially a sink of atmospheric NH_3 while the paddy field turned into a source of atmospheric NH_3 when nitrogen fertilizers were applied particularly by surface broadcast. In addition, uncertainties originated from weekly measurements will also be discussed in the workshop.

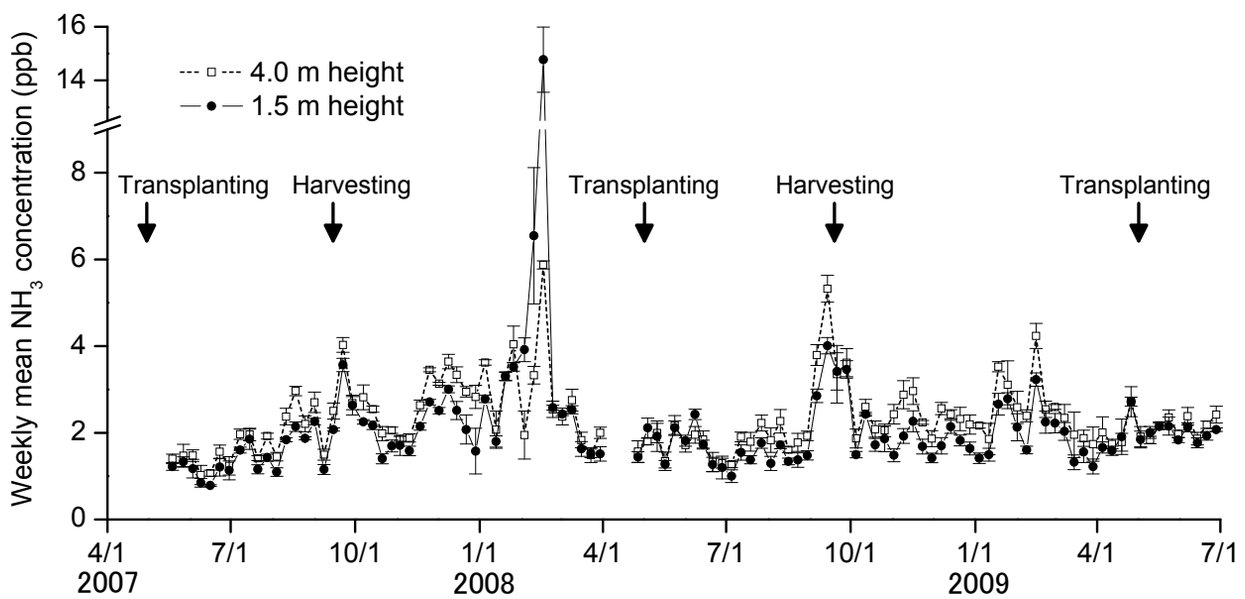

Fig. 1 Weekly means of atmospheric NH_3 concentration at a paddy field in central Japan.

O53

SPATIAL PATTERNS FOR LEAF NITROGEN AND PHOSPHORUS STOICHIOMETRY OF TEMPERATE FOREST ECOSYSTEMS IN NORTHEASTERN CHINA

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Nitrogen (N) and phosphorus (P) are important stoichiometric indexes for describing the ecophysiological traits of plant leaves, and regional scale patterns of leaf stoichiometry are important to understand and forecast ecosystem processes under global change. A total of 513 leaf samples taken from 41 dominant species at 57 sites of temperate forest ecosystems in northeastern China were taken to explore spatial patterns of leaf N and P stoichiometry. Leaf geometric means of N content (on mass base, Nmass), P content (on mass base, Pmass), and N/P ratio (on mass base) were 17.59 mg/g, 2.64 mg/g, and 6.59, respectively. Compared to Chinese and global flora, leaf Nmass was slightly lower, leaf Pmass was significantly higher, and N/P ratio was significantly lower in the studied region. It can be concluded that temperate forest ecosystems are N limited in northeastern China, and an increase in N deposition in the future would give rise to at least a short-term increase in net primary productivity. With the increases of latitude, mean annual temperature (MAT), and mean annual precipitation (MAP), leaf Nmass and Pmass exhibited parabolic changes with increases at the beginning and decreases after arrival of their maxima. Species and climatic factors were the two primary variables that affected leaf N and P stoichiometry in the region, accounting for 53.69%, 65.53%, and 55.85% of the total variation of leaf Nmass, Pmass and N/P ratio, respectively, while life form accounted for less than 1%. This study suggests that climatic variation and between-species variation, rather than life form variation, are the major determinants of forest foliar N and P stoichiometry in northeastern China.

Oral

O54

CAN INTRA-ANNUAL STABLE ISOTOPE SIGNALS IN TREE-RING CELLULOSE BE USED TO EXTEND FLUXNET DATA-MODEL ANALYSIS TO LARGER TEMPORAL AND SPATIAL SCALES?

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Eddy-covariance measurements are essential to validate forest ecosystem models but, to constrain predictions over larger forested areas or longer time frames, complementary datasets are required. High-resolution intra-annual measurements of the carbon and oxygen stable isotope composition of cellulose in annual tree rings ($\delta^{13}C_{cellulose}$ and $\delta^{18}O_{cellulose}$) may provide a solution. This is because well-defined seasonal patterns of plant carbon and water dynamics are recorded in tree ring cellulose over the growing season in response to climatic variability. We explored this potential by collecting a 11-year, high-resolution cellulose dataset from maritime pine trees growing at the FluxNet site Le Bray. This isotopic dataset was used with a mechanistic model to perform a sensitivity analysis on the main parameters and climate variables and identify aspects of the model constrained best by the isotopic chronologies.

O55

PHENOLOGY AND GROWTH OF DIFFERENT VEGETATION TYPES IN THE ENT DYNAMIC GLOBAL TERRESTRIAL ECOSYSTEM MODEL (DGTEM) EVALUATED AT FLUXNET SITES

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The Ent Dynamic Global Terrestrial Ecosystem Model (DGTEM), is a new DGTEM for coupling the fluxes of water, energy, carbon and nitrogen between land surface and climate models, for simulating seasonal growth and decay of vegetation, and for simulating decadal- to century-scale vegetation cover change.

This study shows the use of Fluxnet data in evaluating vegetation phenology, carbon allocation, and growth in the Ent DGTEM, and the performance of these algorithms at the global scale forced by Global Soil Wetness Project-2 (GSWP2) meteorology. Ecosystem types modeled include temperature broadleaf cold-deciduous forest at Harvard Forest, MA, and Morgan Monroe State Forest, IN; drought-senescent Mediterranean oak/annual grass savanna at Tonzi Ranch, CA, and annual grassland at Vaira Ranch, CA; and radiation phenology of tropical rainforest in Tapajos National Forest, Brazil. Site-level simulations forced with Fluxnet meterological data are evaluated by comparing the simulated leaf area index (LAI), carbon stocks in plant carbon pools, and carbon and water fluxes between land and the atmosphere against observational data. Global-scale simulations forced with GSWP2 data for 1986 to 1995 are performed to answer the question of whether the model, well-constrained against the local observations over the limited number of years, extrapolates well to global scales and captures interannual variation over the course of 10 years. Further simultaneous optimization of biophysical, leaf, allometric, and turnover parameters within the bounds of observed values is to be conducted to rectify carbon imbalances caused by parameter sensitivity.

O61

CHARACTERISTICS OF HEAT, WATER VAPOR AND CO_2 FLUXES ABOVE A MOUNTAINOUS CRYPTOMERIA FOREST

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Two eddy flux towers were built to study the characteristics of heat, water vapor, and carbon dioxide fluxes over the Sitou Forest Recreation Area of National Taiwan University, Taiwan. This forest area is located in middle Taiwan (23°39'50.1"N, 120°47'46.4"E) and in a valley, three sides surrounded by mountains. This site is a uniform-age (57 years old) managed Japanese Cedar (Cryptomeria japonica) forest that extends 1 km in the north-south direction and 0.8 km in the east-west direction. The mean canopy height is 28 m. The elevation of this area is between 800 - 2000 m a.s.l. and has a slope of 13.6 degree. The elevation of the flux towers is around 1250 m. This site is warm and humid. The average annual temperature and rainfall are 16.6℃ and 2635.18 mm, respectively. The average relative humidity is around 86%.

From our eddy-covariance measurements, we have found that the fluxes measured at 33 and 40 m were the same. This demonstrates that a constant flux layer can be established even for a forest on a hilly terrain with a slope of 13.6 degree. Also, the flux-variance relations for heat and water vapor were found to follow Monin-Obukhov similarity theory.

O62

EXPLORING SOIL CO_2 FLUX OF TROPICAL FOREST IN THE 52-HA LAMBIR HILLS FOREST DYNAMICS PLOT

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Carbon allocation and cycling processes in tropical forests are still poorly quantified and their relationship to environmental factors not well understood. Almost all recent advances in these studies have occurred in the Neotropics (Amazonian and central America), with very few studies in Asia. However, the Malesian tropical forests are fundamentally different from Neotropical and African forests, with their dominance by dipterocarp trees, and inherently different magnitude of biomass and productivity. Variation in the pattern of allocation of carbon may explain these differences in magnitude. Here we focus on an intensive approach to capture monthly soil CO_2 flux on clay and sandy loam sites similar to study sites undertaken across Amazonia. The measurements were taken in primary tropical forest at Lambir Hills National Park, in Sarawak, Malaysia. Understanding diurnal cycle of soil respiration is important to capture spatial and temporal variations. Hence, we established the long-term DIRT (Detritus Input Removal and Transfer) Experiment to partition and manipulate soil organic matter. We employed the LI-8100 automated soil CO_2 flux system (with 4 long-term chambers) to capture continuous soil CO_2 flux on soil partitions under different treatment conditions (control, mycorrhizal, root/litter-free soil, and litter-free soil). Initial results demonstrate that soil CO2 flux correlates with the influence of above- and belowground plant inputs. The study aims to establish estimates of belowground production and allocation of carbon between roots, mycorrhizae and autotrophic respiration, and establish the influence of variation in environmental conditions within the belowground carbon cycle on hourly, daily, synoptic and seasonal timescales.

Oral

O63
ESTIMATION OF THE REGIONAL EVAPORATION WITH COMPLEMENTARY RELATIONSHIP AND CONVECTIVE BOUNDARY LAYER MODEL IN THE SOUTH OF LOESS PLATEAU, CHINA

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We estimated regional evaporation of semi-arid area in China using the combined method of complementary relationship theory with convective boundary layer (CBL) model. This estimation method was proposed by Sugita *et al.* (2002). Complementary relationship between Penman-type potential evaporation E_p and actual evaporation E_a were expressed by $E_a = \eta E_{po} - E_p$, where E_{po} is true potential evaporation in the fully wet environment simulated by CBL model with the bulk resistance $r_{st} = 0$, and η is the coefficient initialized to 2.0. E_a and η were reevaluated more than once in the iteration process. We adjusted CBL model to calculate evaporation every 30-minite in daytime, although the time resolution of original method was once a day. The study site is Chang-Wu flux station (35°12′N, 107º40′E) in the south-west of Loess Plateau, where annual mean precipitation is 584 [mm] and mean temperature is 9.1 [^{o}C]. Flux and Radiation Observation System (FROS) and Microwave Radiometer (MWR) were installed at this site. The upper boundary condition of D was estimated from the profiles of temperature and water vapor density observed by MWR. The using data is from May to July in 2005, which were in the growing and harvesting season of wheat. We also calculated evaporations with Bowen-ratio method (E_{bowen}) and eddy correlation method (E_{eddy}) and compared with each other.

We found that the iteration process improved estimation although the number of success in estimation with iteration was reduced to 0.60 times of that without iteration. The results of linear regression analysis ($y = ax + b$) were $a = 0.31$, $b = 98.0$ [W/m^2] in the comparison of lE_a with lE_{eddy} and $a = 0.66$, $b = 94.8$ [W/m^2] in the comparison of lE_a with lE_{bowen}. E_a fitted better E_{bowen} than E_{eddy}, except when dense fog covers whole the observation site and E_{bowen} was overestimated because of declining D. E_a was sometimes much larger than others around noon. It also happened that E_a declined suddenly while net radiation remained high. The authors have been investigating the causes of these unexpected events and will improve this estimation method.

O64

IMPACT OF TEMPORAL VARIATION OF kB -1 ON THE SIMULATION OF CARBON EXCHANGE IN A FOREST CANOPY

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We examined the impact of temporal variation in kB－1, the logarithm of the ratio between momentum and scalar roughness length, on the simulation of carbon exchange in a temperate deciduous forest canopy. A biosphere model coupled to a dynamic vegetation model with different kB－1 parameterizations resulted in up to 40% difference in the annual gross primary production (GPP). The kB－1 parameterization played a critical role in simulating not only the annual GPP but also the seasonal and inter-annual variations of ecosystem carbon exchanges. When leaf area index was incorporated in the parameterization, the model performance improved to simulate temporal variation of GPP. For a robust simulation of variability of terrestrial carbon cycles, the temporal variation in kB－1 should be appropriately implemented in the parameterization.

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Oral

O65

DATA-MODEL FUSION FOR IMPROVING LAI MAPPING: A CASE STUDY OVER CHINA'S LANDMASS

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Abstract A simple data-model fusion method is developed to improve leaf area index (LAI) mapping using satellite data. The objective is to overcome two issues with satellite-derived LAI maps: (i) optical remote sensing data are often seriously affected by the atmosphere due to clouds, and in some areas no reliable data are obtained in the whole growing season, and (ii) seasonal variations in conifer LAI derived from satellite data are often distorted by the seasonal variations in leaf greenness (pigments), the background vegetation and snow covers, etc., and the derived LAI reflects the overall greenness rather than the actual forest leaf area present in a pixel. These shortcomings of satellite measurements can be greatly alleviated when an ecological model is used to simulate the LAI in the absence of reliable remote sensing data and to estimate the seasonal variation of LAI according ecological principles. The usefulness of this fusion method is demonstrated through improving a China-wide LAI map series in 10-day intervals at 1 km resolution using the VEGETATION data.

Key words: Data-model fusion, LAI, cloud, seasonal variation, upscaling

O66

THE POTENTIAL OF CARBON SINK/SOURCE OF JAPANESE FOREST SOILS

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It has been predicted that global mean temperature will increase about 4°C (ranging 1.1~6.4°C) (IPCC2007). Most of the carbon cycle models apply the exponential functions to predict the future global heterotrophic respiration with a Q_{10} of 2.0. In their models, global heterotrophic respiration increases exponentially with climate warms at an average rate of 6.2% per ºC, and resulting that the current carbon sink of terrestrial ecosystem will convert to a carbon source after 2050. The ultimate objective of our project is to estimate the carbon emission rate of whole Japanese forest soils under the climate change by using multi-approaches, including the field soil warming experiment, open-top chamber facility, cross-country soil incubation and model simulation.

Since 2000, we began to continuous measure soil CO_2 effluxes at the flux tower sites in three Japanese larch plantations, by using the multichannel automated chamber system. In 2007, we installed three soil warming experiment sites at three typical Japanese forest ecosystems, including a 35-year-old cool-temperate mixed forest in northern Hokkaido (Teshio), a 50-year-old Japanese red pine in Kantou region (Tsukuba), and a 25-year-old ever-green Japanese oak forest in Chyugoku region (Hiroshima); In 2008, we installed another three sites: a 300-year-old Japanese beech in Cyubu region (Mt. Naeba), a 40-year-old cool-temperate deciduous-broadleaf forest in north-east region (Mt. Iwaki), and a 50-year-old sub-tropical ever-green forest in Kyusyu region (Miyazaki) (Fig. 1). We installed fifteen automated chambers (0.9m×0.9m×0.5m, L×W×H) at each site for continuous measurement of soil CO_2 efflux. We made ten 1m×1m (40 cm in depth) root exclusion plots. To prevent in growth of new roots, after the trenching treatment, we inserted a plastic sheet down to 25 cm around the edge of the plot. Half of the trenched plots (five plots) at each site were used for soil warming experiment, and the other half of the plots were used as control plots by keeping them in the ambient environment. For the soil warming plots, an 800W infrared heater was vertically hanged over the center of the plot at 1.6m above the soil surface. Compared to the control plots, the infrared heater could warm the soil for 3.0, 2.5, 2.0, 1.7, and 1.5°C at depth of 0, 5, 10, 20, and 30cm, respectively.

The primary results in 2007 and 2008 showed that heterotrophic respiration increased at a rate between 3.5% and 19% per °C, in corresponding with soil organic carbon (SOC) density as well as the regional climate.

To date, we have collected about 1,500 soil cores (0-30 cm depth and 11 cm in diameter), 18 cores each site, from more than 80 forest ecosystems that covered from northern Hokkaido to southern Okinawa, for studying the mechanism of the incubated soil microorganisms in response to the temperature and soil moisture changes. The soil samples were divided into three groups. Each group was automatically incubated at a phytotron with temperature increased at 3 degree every 2-week, and the three phytotrons cover the temperature range from 5 to 30°C. SOC and microbial activities were measured periodically. Moreover, soil CO_2 efflux were monitored by using a 24-channel automated chamber system.

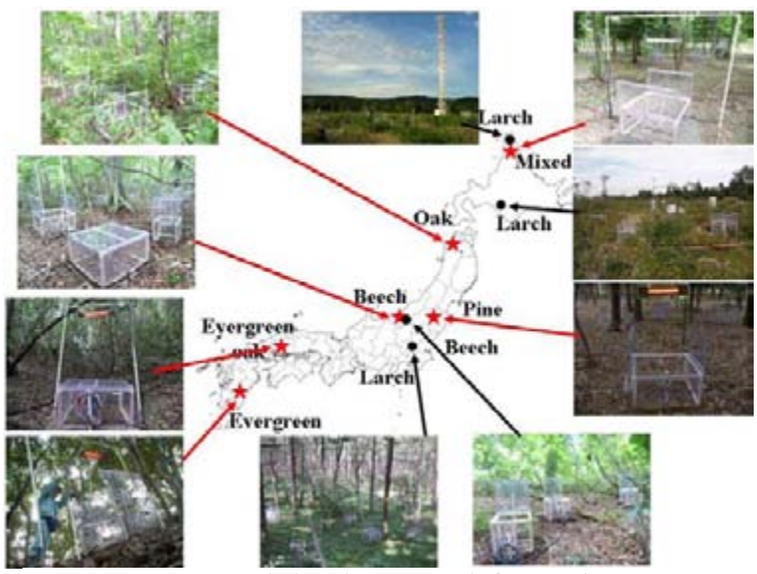

Fig. 1. An automated chamber network for continuous measurement of soil CO_2 efflux.

Oral

O71
ASIAFLUX – SCIENCE COMMUNITY SUSTAINING ECOSYSTEMS AND PEOPLE THROUGH RESILIENCE THINKING

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Resilience thinking captures the dynamic nature of the world. It recognizes the dangers of optimizing for particular states or products of a system, and explains why current approaches to managing resources are failing. 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 – institutional capacity to respond to environmental feedback, to learn and store understanding, and be prepared and adaptive to allow for change. Building resilience will require the dynamic interplay between diversity and disturbance, along with recognition of cross-scale dependencies. Resilience thinking encourages scientists and practitioners to work together with the public to produce trustworthy knowledge and judgment that is scientifically sound and socially robust. The science, service, and stewardship of AsiaFlux are complementary with resilience thinking in ways that we provide qualitative monitoring, management, and long time-series of local observation and ecological and social memory for understanding ecosystem change throughout the adaptive cycle.

AsiaFlux celebrated its 10-year's science, service, and stewardship in November 2008, by hosting the 7th International AsiaFlux Workshopin Seoul, Korea. During this workshop, entitled "Re-thinking global change science: from knowledge to policy," the refined vision of AsiaFlux was cast, i.e., to serve as "science frontier" in carbon, water and energy cycles by developing and transferring scientific knowledge. By 2011 AsiaFlux aims to provide a report on the Asian carbon (and water) budget with its global perspective and develop an infrastructure for Asian carbon (and water) tracking system (ACTS), a synthesized measurement and modeling system that keeps track of emissions and removal of CO_2 (and H_2O) in Asia. Reliable knowledge can become socially robust knowledge only if the society perceives the production process to be transparent, open and participative. This, in turn, depends on reciprocity in which public understands how climate change science works but, equally, climate change science understands how the public works. The AsiaFlux vision will guide such an enhanced mutual understanding and we want to communicate and demonstrate it by embracing resilience thinking. AsiaFlux will continue to create space to deal with emerging paradigms for re-thinking science processes such as cultural boundaries and authority of climate change science, its co-evolution with risk society, context-sensitive science, and the challenge of nurturing diverse functional groups. The latter includes: knowledge carriers and retainers, interpreters and sense makers, networkers and facilitators, stewards and leaders, visionaries and inspirers, innovators and experimenters, entrepreneurs and implementers, and followers and reinforcers.

O72

CLIMATE CHANGE AND ACTIONS FOR A TRANSITION TO LOW-CARBON ECONOMIES

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Climate change represents a grave threat to human society. International community adopted the United Nations Framework Convention on Climate Change in 1992, and agreed to the Kyoto Protocol entailing legally binding targets for developed country Parties at COP3 in 1997. While the Kyoto Protocol is an important first step in addressing the issue of climate change, further steps will be required. International community launched in 2007 a new round of intense negotiation with a view to building climate regime beyond 2012, when the Kyoto Protocol's commitment period will expire.

Messages from scientists, most notably IPCC Fourth Assessment Report (2007), have had far reaching impact on political and business leaders across the globe. With a view to responding vigorously to the serious challenge of climate change, leaders of G8 and other countries participating in the Major Economy Forum shared the recognition that the global average temperature above pre-industrial levels ought not to exceed 2°C (L'Aquila, Italy, June 2009). This goal roughly corresponds to the stabilization level of 450 ppm CO_2-eq., and in order to achieve this stabilization level, global CO2 emissions need to be reduced by 50-85% from their 2000 levels by 2050, and the range of emission allowances for developed countries in 2050 would be a reduction by more than 80%, and in 2020 by 25-40% from their 1990 levels (IPCC, 2007).

Against this background, many countries, both developed and developing, have begun to take actions toward a transition to low-carbon economies. G8 countries established LCS-Rnet, a network of research institutes from G8 countries working for low-carbon societies. The Government of Japan decided an Action Plan to Build a Low-Carbon Society in 2008. While economic stimulus packages with strong component of green investment, which Japan and several other countries have launched in the faced of serious financial and economic crisis, represent a major step forward toward low-carbon, resource efficient economies, strong, sustained and longer-term policy initiatives must follow in order to accelerate a change toward a more fundamental transformation of our economies.

This transformational change toward low-carbon, resource efficient economy would have far reaching economic and social implications. Policy makers, business and civil society need to be informed of the costs and benefits of actions required to this transformation. Science is expected to support decision-making, and for this purpose further efforts would be required to promote research on physical scientific aspects of the climate system and climate change including global carbon cycle, natural and socio-economic impacts of climate change, and the assessment of options for mitigating climate change.

Oral

O73

CARBON FLUX ASSOCIATED WITH LAND USE, MANAGEMENT AND DISTURBANCE ALONG AN URBAN TO RURAL GRADIENT

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Carbon flux measurements and carbon dioxide concentrations were taken along an urban to rural gradient from Baltimore, Maryland, to the New Jersey Pine Barrens. These gradients incorporate the effects of urban vegetation, CO_2 emissions from energy use, the effects of land use, as well as natural disturbances and forest management in forested lands and in heavily vegetated non-forest lands. The urban tower in Baltimore is in a mixed deciduous forest, and monitors carbon flux dynamics and carbon dioxide concentrations in this urban/suburban environment. The three rural towers in the Pine Barrens have monitored carbon flux under management and disturbance. Results are presented showing the effects of anthropogenic cycles associated with the work week, land use, vegetation cover, prescribed burning, defoliation and inter-annual climate variability.

Measurements of eddy-fluxes in an urban landscape create technical difficulties due to the CO_2 emissions signal from energy use as well as the heterogeneity of land use in the tower's footprint. Vegetation cover surrounding the Cub Hill tower averaged 64 %; and ranged from 46% to 77 % in different quadrants. Using a closed-path eddy-covariance system, we obtained net ecosystem exchange (NEE) values stratified according to wind direction with source areas of different vegetation cover and land use composition. Annual net CO_2 exchange at the Baltimore LTER flux site indicated that this urban site was a net source of ranging from 500-1000 g C m^{-2} yr^{-1} from 2004-2008, with the largest losses occurring during the winter months, due to high CO_2 emissions from fossil fuel energy use as well as leaf-off conditions of the deciduous tree cover.

We collected similar data to quantify C dynamics from the rural forest ecosystems in the New Jersey Pine Barrens that experienced invasive insect defoliation, prescribed fires and wildfires. The impact of Gypsy moth (*Lymantria dispar* L) on carbon dynamics was monitored before defoliation (2005 baseline), with partial defoliation (2006), and with complete defoliation (2007) on an oak-dominated stand, and partial defoliation of the mixed oak-pine and pine-dominated stands. NEE at these three rural towers ranged from -137 to -204 g C m^{-2} yr^{-1} prior to disturbance. Gypsy moth defoliation severely reduced fluxes and resulted in a loss of 294 g C m^{-2} yr^{-1} in the oak dominated stand and 129 g C m^{-2} yr^{-1} in conifer dominated stands in 2007. Prescribed fire management treatments resulted in C losses of 7 to 474 g C m^{-2}, with an average of 244 g C m^{-2}, resulting in moderate sources of CO_2 to the atmosphere on an annual basis. In comparison, uncontrolled wildfires in 2007 were estimated to release approximately 1580 ± 350 g C m^{-2}.

Disturbances such as insect defoliation, wildfires, and prescribed burns are major factors controlling NEE in rural forests. These natural forested ecosystems recovered from all disturbances and approached C neutrality relatively rapidly. The urban tower showed C uptake during the growing season due to the high percentage of vegetation cover. However, CO_2 emissions from energy use makes the urban site appear to be a large net source on an annual basis. This research shows the range of C losses that can be expected across an urban to rural gradient under the influence of anthropogenic emissions, land use, forest management and natural disturbances.

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IMPACT OF METEOROLOGICAL ANOMALIES IN THE 2003 SUMMER ON GROSS PRIMARY PRODUCTIVITY IN EAST ASIA

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Northern Eurasia experienced anomalous weather conditions in the 2003 summer. We examined how forest ecosystems responded to the meteorological anomalies during the period using the dataset collected at flux monitoring sites in Asia, including a boreal forest in Mongolia, temperate forests in China and Japan, and a sub-tropical forest in China, as well as the dataset from satellite remote sensing.

From July to August 2003, an active rain band stayed in the mid-latitude in East Asia for an unusually long period. Under the influence of the rain band, the gross primary production (GPP) of temperate forests was 20-30 % lower in the 2003 summer than in other years due to significant reduction in the photosynthetic photon flux density (PPFD). The GPP of a cool-temperate forest in the north of the rain band was slightly enhanced by the higher PPFD; however, the GPP of a sub-tropical forest located in the south of the rain band was reduced by drought stress due to extremely hot and dry conditions.

The correlation coefficients for the year-to-year changes in the PPFD and GPP during mid-summer were calculated, and the spatial distribution was examined. The spatial pattern of the PPFD was calculated by satellite data, and that of the GPP was estimated by a regression-type model, which was trained and tested by ground observation data. The correlation was positive in the mid- and high-latitudes since light was an essential factor of the summer GPP. On the other hand, a negative correlation appeared in the lower latitudes, suggesting that the water limitation was much more important than the PPFD in the region.

Our study illustrated that the integration of flux data from wide areas by combining satellite remote sensing data can help us gain an understanding of the ecosystem responses to large-scale meteorological phenomena.

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REPRODUCING LONG TERM ECOSYSTEM CARBON BALANCE OF EAST SIBERIAN LARCH FOREST BY INTERPRETING BIOMASS, DENDROCHRONOLOGY, SOIL CARBON AND CLIMATE RECORDS

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Response of ecosystem carbon balance to climate is one of the key uncertainties on future projection of the global climate change through positive and negative feedbacks. Flux observation by means of eddy covariance measurement may provide precise information of ecosystem carbon cycle and its response to environment, however most of long term flux experiments have not reached 10 years so that are not long enough to predict the response to full range climate variation which is expected to occur in future. Whereas, tree rings record a history of tree growth which must affect the ecosystem carbon cycle and is also expected to be indicators of the response to climate variation. However, tree rings are changeable not only by climatic conditions but also by ecological conditions of stands and tree age. Furthermore, they do not represent biomass growth of an ecosystem but that of individual live trees because they do not reflect stand density or mortality, thus there are seldom reports that successfully reproduced ecosystem carbon cycle from dendrochronological records.

This study challenges reproducing long term ecosystem carbon balance of a forest stand by comprehensively interpreting various information of ecosystem and climate; stand biomass growth and soil carbon change by forest stand inventory, tree ring and climate records as well as short term flux tower observation. The measurements and information of larch (*Larix gmelinii*) stands near Yakutsk, east Siberia was collected. Larch communities in this region generally form after severe fire events and are relatively uniform, so that age dependent response of the trees is expected to be uniform in a stand. Fig. 1 shows information flow of the proposed method to reproduce long term ecosystem carbon balance. Neither stem density nor mean tree biomass of different stand age was fitted by any functions, whereas stand biomass can be estimated by a logistic curve. Tree ring width and stem diameter were used to predict relative tree biomass growth, mortality and litter productivity using empirical allometric functions, so that, its variation can be considered in calculated stand biomass growth. NPP was calculated by summing stand biomass growth and litter biomass production, and CWD from stand biomass and mortality. Soil carbon turnover was calculated by using RothC model (Coleman and Jenkinson, 1999) to predict heterotrophic respiration. Finally, NEP was estimated.

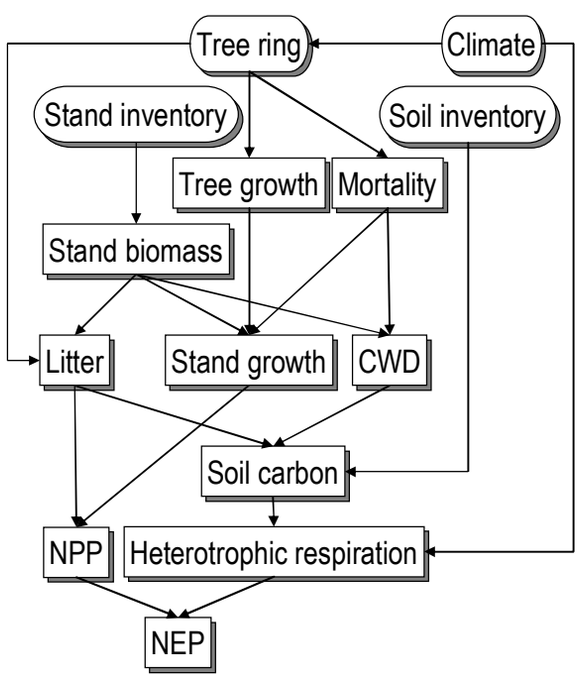

Fig. 1 Information flow of long term carbon balance reproduction by using stand inventory and dendrochronological and climatic data.

Normalized tree ring width index averaged among 14 trees ranged from 0.1 to 2, and consequently, estimated NPP and NEP showed quite large inter-annual variation. The tree ring index significantly correlated with observed GPP and ecosystem respiration in 7 years, however less strong with NEP, which indicates that direct estimation of NEP by tree ring is difficult and that a comprehensive interpretation process is needed to reproduce variation in NEP. Several temperature and precipitation indicators affected the tree ring index, however the definitive factors were not found.

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SIMULATING CARBON BALANCE OF LARCH FORESTS IN EAST ASIA FROM STAND TO REGIONAL SCALE

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The northern high latitude region is currently undergoing rapid and drastic warming. The terrestrial ecosystems in this region have responded to the warming climate through various feedback processes. Larch forests are widely distributed in these regions, and expected to play an important role in global carbon and water cycles. Although a number of studies based on the ecosystem models have predicted the carbon cycle in this region, a lack of sufficient validations limited its applicability until recently. In this study, a process-based terrestrial biosphere model, BIOME-BGC, was tested to larch forests at six AsiaFlux sites, and used to identify important environmental factors on the carbon and water cycles in both temporal and spatial scales.

In this study, we extended the BIOME-BGC model to incorporate the soil freezing and thawing dynamics, dynamic allocation for new fine root C to new leaf C constrained by the climate of annual air temperature and precipitation. The model was validated at six tower sites in larch forests distributed from boreal Siberia to cool temperate regions (Ueyama et al., 2009). For the spatial analysis, we used climate data from 1979 to 2008 at 0.2×0.2^{o} spatial resolution using JRA-25 climate data. To identify the pixel of larch forest, we used a landcover classification map of MOD12. To validate the model performance of both default and improved models at the regional scale, we conducted the correlation analysis at the spatial and temporal scales; correlation coefficients between climate variables and satellite-derived NDVI (AVHRR-GIMMS) were examined from 1982 to 2006, and then compared with the correlation between climate variables and the simulated GPP, assuming that the satellite-derived NDVI could be surrogate for anomalies of GPP.

Using observed fluxes as a calibration data, the modified BIOME-BGC model successfully simulated the carbon fluxes at daily, monthly, and annual time scales. In the stand and regional scale analyses, (1) the calibrated model by the observed data was significantly improved in both stand and spatial scales, (2) anomalies in satellite derived normalized difference vegetation index (NDVI) weakly correlated with the precipitation with a one-year lag and air temperature, and (3) the sensitivity of gross primary productivity (GPP) to weather conditions was spatially changed; radiation controlled GPP in the southern region, precipitation limit GPP in the eastern region, and the increase in growing season air temperature uniformly enhanced GPP. According to the regional simulation, GPP and RE in mature larch forests in northern Eurasia to East Asia is 851 and 838 g C m^{-2} y^{-1} between 1979 and 2008, indicating that the forest acted as a small carbon sink of 13 g C m^{-2} y^{-1}.

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Poster I

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THE IMPROVEMENT OF PHENOLOGY MODULE FOR SUMMER GREEN TREE IN CLM3.5-DGVM USING MODIS LAI

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Phenology module of CLM3.5-DGVM has been improved using the year 2006 MODIS land products in temperate mixed or deciduous forests in Korea. Plant phenology plays an important role in simulating energy and mass exchange in model. The phenology module of CLM3.5-DGVM for summer green tree has deficiency in that the model simulates too short leaf expansion period in spring and the time of leaf fall is late by one month, resulting in an overestimation of growing days. To improve the phenology module for summer green tree, we used 1-km resolution 8-day MODIS LAI data, surface air temperature data at Korean Meteorological stations, and 1-km resolution land use data. The phenological dates have been determined using MODIS LAI following the detection algorithm of Zhang et al. (2003).

To examine if MODIS LAI captures the observed seasonal variation of LAI, we compared the seasonal variation of MODIS LAI with the observed plant area index of a temperate deciduous forest at Gwangnung. The comparison results showed that MODIS LAI captured the seasonal variation of plant area index such as leaf-out, leaf-maturity and an end of leaf fall but showed difference for the beginning of leaf senescence. MODIS LAI decreases from early September due to leaf coloring while the observed plant area index does not decrease significantly until late October. This may be due that plant area index includes both green leaf and colored leaf.

To examine the relationship between the phenological date and the meteorological variable, we selected study areas within a 10-km radius of Korean Meteorological stations which have 20-year climatological records. The areas without mixed forest or deciduous forest are excluded and also the areas with bad quality of MODIS data have been excluded. Finally, 21 study areas are selected and used in the analysis. Mean LAI at 21 areas was calculated using LAI value from the pixels with the best and good quality. The calculated phenology dates range from DOY (day of year) 105 to 118 for leaf-out and from DOY 301 to 315 for an end of leaf fall. The 10-day mean air temperature on leaf out and leaf fall dates show good correlation with the 20-year mean coldest month temperature, which is consistent with the original module but coefficients are different. The original module assume that leaf reaches maturity when growing degree day (GDD) is larger than 150 while GDD at leaf-maturity shows good correlation with 20-year mean coldest month temperature. New coefficients and formula for phenology module have been suggested using MODIS data in 2006. The performance of improved module has been examined and discussed. The improved phenology module is expected to contribute to better simulation of surface fluxes in CLM3.5-DGVM.

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ESTIMATING PARAMETERS IN AN TERRESTRIAL ECOSYSTEM MODEL WITH EDDY COVARIANCE FLUX MEASUREMENTS

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Model parameter uncertainty is a major source of uncertainties in predicting terrestrial carbon cycle dynamic. The eddy covariance flux technique makes parameter estimation in terrestrial ecosystem models possible at an ecosystem level. The Bayesian probability inversion and a Markov chain Monte Carlo (MCMC) technique were applied to estimate parameters in a terrestrial ecosystem model with eddy covariance flux measurements. Key model parameters optimized in this study were the maximum photosynthetic carboxylation rate ($V_{cmax,25}$) at a reference temperature of 25 ^{o}C, the Ball-Berry coefficient a_1, and the reference respiration rate (R_s). Eddy covariance flux measurements used to estimate parameters were from an evergreen forest, a deciduous forest, and a mixed forest. The Markov chain Monte Carlo method provided posterior probability distribution of the model parameters. Uncertainties and seasonal variation of such parameters were analyzed based on the posterior estimates in each forest site. Optimizing the key parameters in the terrestrial ecosystem model improve the ability to predict the net exchange of CO_2 between vegetation and atmosphere.

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FOLIAR AND SOIL NATURAL ABUNDANCE OF ^{15}N PROVIDES FIELD EVIDENCE ON NITROGEN UPTAKE AND NITROGEN TRANSFORMATION IN TEMPERATE FOREST ECOSYSTEMS

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Abstract: The natural abundance of stable ^{15}N isotopes in soils and plants is potentially a simple tool to assess ecosystem N dynamics. Several open questions remain, however, in particular regarding the mechanisms driving the variability of foliar and soil $\delta^{15}N$ values within and across ecosystems. The aim of the research was therefore to: (1) clarify the patterns of foliar and soil N concentration and their $\delta^{15}N$, and soil N transformation rates within four temperate forest ecosystems along a mountain transect; (2) to determine in situ if a plant's preference for NO_3^- or NH_4^+ uptake explains variability in foliar $\delta^{15}N$; and (3) characterize the relationship between soil N transformation rates and variability of enrichment factor ε ($\delta^{15}N_{leaf}$ - $\delta^{15}N_{soil}$) values within forest ecosystems. The variation of foliar N contents was consistent with those of soil available N and NO_3^--N rather than NH_4^+-N contents. The $\delta^{15}N_{NO3-}$ and $\delta^{15}N_{foliar}$ trended to decease with altitude, which was similar with the variation of the soil NO_3^-/NH_4^+ ratios. Except NH_4^+-N leaching rate, soil N transformation and loss rates decreased with altitude. The variability in enrichment factor ε values among forests decreased with increasing altitude and was significantly influenced by N transformation and loss rates. Our findings improve the mechanistic understanding of the commonly observed variability in foliar $\delta^{15}N$ among different forests. In particular, our results showed that foliar $\delta^{15}N$ values and enrichment factor ε could nicely reflect plants' N uptake and soil N transformation across different forest ecosystems.

Key words: Stable isotopes; N transformation; Plant N uptake; Enrichment factor; Temperate forest; Mountain transect

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PRECIPITATION PATTERN DRIVES INTERANNUAL VARIATION IN SOIL RESPIRATION IN A SUBTROPICAL CONIFEROUS PLANTATION

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Seasonal and interannual variation of soil respiration (R_S) were studied using a 5-year-data set in a seasonally drought-stressed coniferous plantation in subtropical China. The seasonal variation was mainly driven by soil temperature (T_S), but the response of R_S to T_S was significantly constrained by soil water content (*SWC)*. The temperature sensitivity of R_S (Q_{10}) was obviously reduced when the *SWC* below a threshold of 15% V V^{-1}. The T_S and *SWC* together could explain 74-91% of R_S. The annual R_S was estimated to be 669±68 gC m^{-2} yr^{-1} (CV=10.2%), ranging from of 564 gC m^{-2} yr^{-1} in 2004 to 750 gC m^{-2} yr^{-1} in 2006 in this coniferous forest. Thought the annual precipitation in this region was more than 1400 mm, the interannual variability of R_S was found mainly contributed from the wet season (from March to June) and the dry season (from July to October). The large interannual variability of R_S was attributed to changes of annual mean *SWC* (R^2=0.91, p<0.01) or variation of annual times of rainfall event (R^2=0.80, p=0.03). This result is quite similar to that in arid or semi-arid regions. The interannual variation of Rs is expected to be aggravated in the future with the changes in precipitation pattern under the climate change.

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DRIVERS OF NITROUS OXIDE FLUXES FROM THE SEMI-ARID STIPA GRANDIS GRASSLAND IN NNNER MONGOLIA, CHINA

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Nitrous oxide (N_2O) is one of the most important greenhouse gases. It is also involved in many essential environmental processes in the terrestrial ecosystem. Soils are the major source for atmospheric N_2O. Grassland soils cover approximately 25% of the total global terrestrial area, and therefore changes in the exchange of N_2O between grassland ecosystems and the atmosphere may have a significant impact on the global climate change.

Two-year round (from January 2005 to December 2006) of nitrous oxide (N_2O) flux in the semi-arid *Stipa grandis* grassland in Inner Mongolia, China was measured with the enclosed chamber technique before and after the removal of all the aboveground biomass. The measurements were made twice per month in the growing season and once per month in the non-growing season. In addition, the possible effect of water-heat factors on N_2O fluxes was statistically examined. The results indicated that there were distinct seasonal patterns in ecosystem N_2O fluxes and soil N_2O fluxes with large fluxes in spring, summer, and autumn but negative fluxes in winter, and the *Stipa grandis* grassland of Inner Mongolia played a role of source for the atmospheric N_2O, with the annual net emissions of the ecosystem N_2O of 0.21–0.26 kg N_2O-N hm^{-2}, and the soil N_2O of 0.19–0.20 kg N_2O-N hm^{-2}, respectively. The annual soil N_2O flux approximately accounted for 73%–95% of the ecosystem N_2O flux, but there was no significance difference between them. The ecosystem N_2O flux was under similar environmental control as the soil N_2O flux. Soil moisture was the primary driving factor of the N_2O fluxes in the growing season of the two years, the changes of SWC of soil surface layers can explain 44.9%–67.1% of the variations of N_2O fluxes. The high seasonal variation of the N_2O fluxes in the growing seasons was regulated by the distribution of effective rainfall, rather than the precipitation intensity. While in the non-growing season, the N_2O fluxes were restricted much more by air temperature or soil temperature, and 82.9%–85.3% of the variations of the N_2O fluxes were induced by the changes of temperature conditions.

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SEASONAL VARIATIONS IN CARBON DIOXIDE EXCHANGE IN AN ALPINE WETLAND MEADOW ON THE QINGHAI-TIBETAN PLATEAU

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The measurements covered three years and were made using the eddy covariance method. Seasonal trends of both *GPP* and *R*eco followed closely changes in Leaf Area Index (*LAI*). *Reco* exhibited the same exponential variation as soil temperature with seasonally dependent R10 values. Yearly average *GPP*, *R*eco, and *NEE* (which were 575.7, 676.8 and 101.1 gCm-2 , respectively, for 2004 year, and 682.9, 726.4 and 44.0 gCm-2 for 2005 year, and 630.97, 808.2 and 173.2 gCm-2 for 2006 year) values indicated that the alpine wetland meadow was a moderately important source of CO2. The observed carbon dioxide fluxes in this alpine wetland meadow plateau are high in comparison with other alpine meadow environments such as *Kobresia humilis* meadow and shrubland meadow located in similar areas. CO2 emissions are large on elevated microclimatology areas on the meadow floor regardless of temperature. Furthermore, relatively low *Reco* levels occurred during the non-growing season after a late rain event. This result is contradicted observations in alpine shrubland meadow. The timing of rain events had more impact on ecosystem *GPP* and *NEE*.

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SIMULATION OF NET PRIMARY PRODUTIVITY AND EVAPOTRANSPIRATION IN EAST ASIA WITH THE REMOTE SENSING DRIVE BEPS MODEL CALIBRATED USING EDDY FLUX OBSERVATIONS

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Poster I

In this study, the process-based ecological BEPS model was employed to simulate net primary productivity (NPP) and evapotranspiration(ET) at 8-km resolution in East Asia during 1982-2006. The BEPS model was driven by meteorological data interpolated from the NCAR/NCEP reanalysis data and remotely sensed vegetation parameters, including land cover and leaf area index (LAI). LAI was produced from the GIMMS NDVI dataset using a look-up table based approach. Prior to the regional simulation, the parameters of BEPS significantly affecting the calculations of canopy photosynthesis and transpiration were calibrated using eddy flux observations taken at six sites in East Asia. Simulated GPP and ET are generally in agreement with observed values. The 10-day variations of ET and GPP explained by the model are in the range from 85% to 96%. The uncertainties in temperature and water vapour pressure of the NCAR/NCEP reanalysis data are the major contributor to the discrepancy between simulated and observed GPP and ET. Simulations show that NPP and ET in East Asia exhibit considerable intrerannual variability, mainly related to fluctuations in climate. Annual NPP and ET demonstrate a gradient, decreasing from the southeast to the northwest. There is a large difference in annual NPP and ET per capita among different regions and countries in East Asia.

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DEVELOPMENT OF EDDY FLUX DATA PROCESSING TECHNIQUE IN CHINA

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Processing method researches and system development for carbon and energy flux data obtained by eddy covariance technique is becoming a focus concerned by flux researchers. A series of software were developed for processing eddy flux data (such as Eddysoft, TK2, EdiRE, Alteddy and so on), and Marqs also developed the web-based system for flux data gap-filling and flux-partitioning (http://gaia.agraria.unitus.it/database/eddyproc/). After integrating the main existing processing methods at home and abroad, Chinese Terrestrial Ecosystem Flux Research Network (ChinaFLUX) proposed a set of relatively complete flux data processing procedure for 30 min flux observation data, and developed the ChinaFLUX flux data processing system (DPS) by make use of advanced information technology. Three types of flux data processing systems were constructed, which were based on MATLAB GUI technology (C/S mode), scientific workflow technology(C/S mode) and web services technology (B/S mode). Flux data processing system based on MATLAB GUI technology provided friendly interface. By making use of the scientific workflow technique (Kepler), flux data processing functions were encapsulated, which will help the sharing and automatic calculation of flux data processing algorithm. The data process system, designed based on web services technologies, not only packages key algorithms, but also constructs a web-based online system which allows multi-user to use at the same time.

The main processing steps of DPS for 30 min flux observation data included quality control/quality assurance of observed data(coordinate rotation, WPL correction, storage calculation ,spike detection and u* correction), gap filling of missing data(MDV mehod,look-up table and non-linear gapfill method, etc.), separation and computation of carbon flux exchange at different time scales and so on. Uncertainty analysis of eddy flux observation and simulation also will be added to the system. By now, ChinaFLUX DPS has been used to process the flux data of ChinaFLUX from 2003 to 2008, meteorology and climate flux data sets of 51sites.year were constructed at different time scales. Extensions and modifications of ChinaFLUX data processing system will offer accurate, convenient and intuitive flux data processing services for researchers and will provide important basic data and powerful technical support for carbon cycle researches.

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INFLUENCE OF ASIAN MONSOON ON INTERANNUAL VARIABIITY OF NET ECOSYSTEM CARBON EXCHANGE IN TWO MAJOR PLANT FUNCTIONAL TYPES IN KOREA

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Considering the feedback loops in radiation, temperature, and soil moisture with alterations in rainfall patterns, the influence of the changing monsoon on net ecosystem CO_2 exchange can be critical to the estimation of carbon balance in Asia. In this paper, we examined the eddy covariance CO_2 fluxes observed from 2004 to 2008 in two major plant functional types in KoFlux, i.e., the Gwangneung deciduous forest (GDK) site and the Haenam farmland (HFK) site. The objectives of the study were to (1) quantify the net ecosystem CO_2 exchange (*NEE*), ecosystem respiration *(RE*), and gross primary production (*GPP*), (2) examine their inter-annual patterns, and (3) assess the mechanism for the coupling of carbon and water exchange associated with the summer monsoon. The GDK site, which had a maximum leaf area index (*LAI*) of ~5, was on average a relatively weak carbon sink with *NEE* of -255 gC m^{-2} y^{-1}, *RE* of 3084 gC m^{-2} y^{-1}, and *GPP* of 3339 gC m^{-2} y^{-1}. Despite about 20% larger *GPP* in comparison with the GDK site, the HFK site (with the maximum LAI of 3 to 4) was even a weaker carbon sink with *NEE* of -173 gC m^{-2} y^{-1} because of greater *RE* of 3797 gC m^{-2} y^{-1}. In both sites, the annual patterns of *NEE* and *GPP* had a striking mid-season depression each year with two or more distinctive peaks of different timing and magnitude, whereas *RE* did not. The mid-season depression at the GDK site occurred typically from early June to late August, coinciding with the season of summer monsoon when the solar radiation decreased substantially due to frequent rainfalls and cloudiness. At the HFK site, the mid-season depression began earlier in May and continued until the end of July due to land use management (e.g., crop rotation) in addition to such disturbances as summer monsoon and typhoons. Other flux observation sites in East Asia also show a decline in radiation but with a lesser degree during the monsoon season, resulting in less pronounced depression in NEE. In our study, however, the observed depression in NEE changed the forest and farmland from a carbon sink to a source in the middle of the growing season, yielding the annual *NEE* near the low end of the range reported in the literature. Such a delicate coupling between carbon and water exchange may turn these ecosystems into a stronger carbon sink with the projected trends of less frequent but more intense rainfalls in this region.

P113
ESTIMATION OF SCALAR FLUXES USING AN AERODYNAMIC VARIANCE METHOD AT A CONIFEROUS FOREST IN GWANGNEUNG, KOREA

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The open-path eddy covariance system is world-widely used to measure ecosystem carbon fluxes. But it suffers from the lack of data during rain events, especially monsoon season in East Asia, due to the poor performance of open path infrared gas analyzer. It's critical because considerable changes in carbon fluxes are known to occur during and immediately after rainfall (Lee *et al.*, 2004). Gaps occurred by rain events can be filled by various gap-filling methods, but contingent bias may be produced by a standard gap-filling procedure. To overcome this problem, an approach based on an aerodynamic variance method has been examined by the authors since 2008.

In an aerodynamic variance method, the frictional velocity and scalar scaling parameters (i.e., potential temperature scaling parameter for sensible heat flux) are estimated based on the Monin-Obukhov similarity theory using the following relationship:

$$\overline{wa} = u_* a_* \qquad (1)$$

where u_* is the frictional velocity and a_* is the scaling parameter for any scalar a.

Our study indicated that the frictional velocity estimated by an aerodynamic variance method was well correlated with observations by a sonic anemometer within ~10% (Fig. 1). Sensible heat flux also showed a significant correlation with observations (Fig. 2).

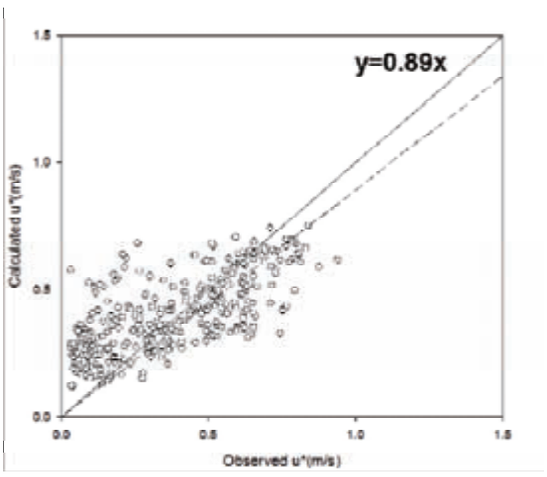

Figure 1. Estimation of frictional velocity(u_*)

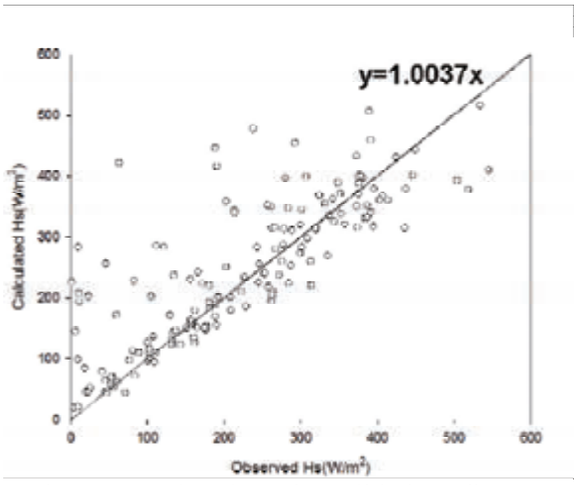

Figure 2. Estimation of sensible heat flux(Hs)

Reference:

Lee X, H. Wu, J. Sigler, C. Oishi, T. Siccama(2004) Rapid and transient response of soil respiration to rain. Global Change Biology 10(6):1017–1026

Dias, Nelson Luis, Jinkyu Hong, Monique Y. Leclerc, T. Andrew Black, Z. Nesic and P. Krishnan (2009) A Simple Method of Estimating Scalar Fluxes Over Forests, Boundary-Layer Meteorology

Acknowledgement

This research was supported by grants (code: 1-8-3) from Sustainable Water Resources Research Center for 21st Century Frontier Research Program, the A3 Foresight Program of the National Research Foundation of Korea, and BK21 Program of the Ministry of Education, Science and Technology of Korea.

Poster I

P114
COMPARISON OF RELATION BETWEEN TEMPERATURE, MOISTURE AND SOIL RESPIRATION IN SOME SITES

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Introduction Soil respiration rates are affected by environmental factors such as soil moisture and soil temperature and soil properties such as root biomass and porosity. Soil respiration rates are affected by many factors in complicated relationships. Therefore, to understand the mechanisms and rates of soil respiration, it is important to estimate the magnitude of the effects of individual environmental and soil property factors on the spatial variation of soil respiration rates. Palmroth et al. (2005) measured soil respiration rates in adjacent pine plantation and hardwood areas in Duke Forest, North Carolina, USA. They reported that differences in soil respiration rates were controlled by the effects of soil temperature, soil moisture, and soil properties. This analysis needs the Equation to indicate the relation between soil temperature, soil moisture and soil respiration rate. The parameters in the equations suggest the soil properties for soil respiration (Palmroth et al., 2005). In this report, the parameters in the equation are compared between some sites.

Materials and Methods The relation between soil respiration (S_r: $mgCO_2m^{-2}s^{-1}$) and soil temperature (T_s: ^oC) is often expressed as Eq. (1).

$$S_r = f(T_s) = a\,EXP(bT_s) \quad (1)$$

Where, a and b are the constant parameters.
When soil moisture (θ: m^3m^{-3}) is added to the independent factor, the relation is often expressed as Eq. (2).

$$S_r = f(T_s)\,f(\theta) = f(T_s)\,\theta/(c + \theta) \quad (2)$$

Where, c is the constant parameter.

30 sets of the parameters a and b were collected from the published paper showing the Eq. (1) for 12 sites. 10 values of parameter c were collected from the published paper showing the Eq.(2) for 4 sites.

Results Parameter a is thought to affect the soil respiration in winter. Parameter a becomes smaller in cooler site (Figure 1). On the other hand, parameter c is supposed to indicate the sensitivity of soil respiration against soil moisture. Parameter c becomes larger in sites with more precipitation (Figure 2).

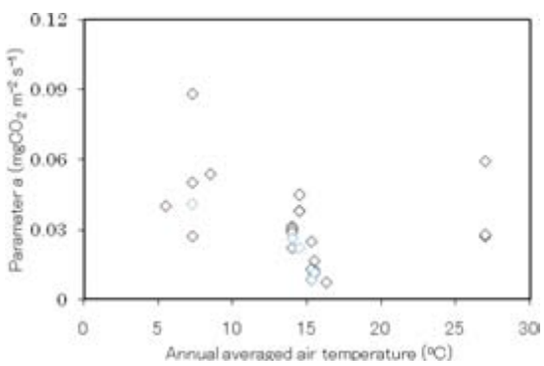

Figure 1: Relation between parameter a and annual averaged air temperature.

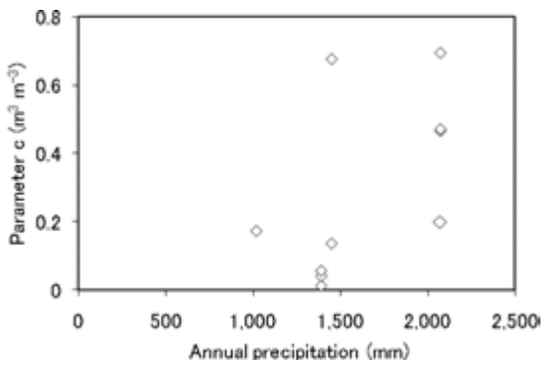

Figure 2: relation between parameter c and annual precipitation.

Reference Palmroth et al. (2005): Global Change Biology, 11, 421-434.

P115

DAILY GROSS PRIMARY PRODUCTIVITY AND EVAPOTRANSPIRATION USING SATELLITE REMOTE SENSING

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Moderate Resolution Imaging Sprectroradiometer (MODIS) provides useful information on daily variations of meteorological and land surface biophysical variables. The variables can be utilized to estimate more complex variables that are not provided with official MODIS products dataset. As well, the current MODIS products are subject to further improvement in their algorithms and operational schemes. In this study, we provide new approaches to estimated daily evapotranspiration (ET) and gross primary production (GPP) using MODIS data only. Because vegetation carbon and water fluxes are strongly coupled with each other, simultaneous estimations on both fluxes can provide useful information on coupling between vegetation carbon and water processes. Our stand-alone MODIS ET and GPP products were evaluated their reliability with eddy-covariance flux measurements from 9 flux tower sites in the East Asia.

Although the comparisons showed appreciable errors in MODIS GPP and ET, the seasonal variation and geographic distribution of those variables resulted in reasonable patterns. The mean biases of GPP and ET ranged from -3.6 to +1.24 gC m^{-2} d^{-1} and from -0.71 to +0.66 mm d^{-1}, respectively. Those errors were corresponded to percent relative errors to the mean measured values from -53 to +48 % and from -28 to 86% for GPP and ET, respectively. Our result indicates potential applicability of MODIS data to evaluate GPP and ET which can be applied to evaluate regional and global scale monitoring on land surface interactions with atmosphere through carbon and water fluxes.

Poster I

P116

EVALUATION OF SATELLITE DATA BASED VEGETATION ANOMALIES WITH ECOSYSTEM MODELS IN ASIA

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Satellite-based data are effective to identify key changes in terrestrial gross primary productivity. However, difficulty due to various noises such as cloud contamination and atmospheric effects sometimes make terrestrial ecosystem monitoring difficult. In this study, we used multiple satellite-based vegetation index data and terrestrial ecosystem models to identify 'robust anomalies' of terrestrial ecosystem status by combining multiple satellite-based vegetation index data, and these anomalies were confirmed by comparison with the results from terrestrial ecosystem models.

We used four different NDVI data from 2001-2006. Data included are Terra/MODIS, SPOT/VEGETATION, NOAA/AVHRR, and SeaWifs. All data were converted to monthly maximum composite with 8km spatial resolution, and normalized anomalies from 2001-2006 data were calculated in each 3-month period. Then, we regarded the pixels where (|normalized anomaly| > 1) for all four data as the pixels with 'robust anomaly.' As an independent check, we also used outputs from terrestrial ecosystem models (Support Vector Machine, CASA, and LPJ). The modeled GPPs were converted to normalized anomalies from base period 2001-2006. 'Robust anomaly' from satellite data was assessed by the model outputs to evaluate whether 'robust anomalies' can be also explained by the models.

The satellite based data shows clear characteristics in interannual variabilities in NDVI. Each data showed different interannual variabilities, and the use of four different satellite data successfully extracted the 'robust anomalies' of terrestrial vegetation activities. These are characterized by (1) spring NDVI anomalies related to temperature anomaly in mid and high latitudinal areas, (2) NDVI anomalies in southeastern and central Asia related to precipitation, and (3) summer NDVI anomalies in 2003 related to strong anomalies in solar radiations. The model results generally agree with satellite-based NDVI anomalies (Fig. 1). However, NDVI anomalies related to radiation ones (2003 summer) were not accurately captured by terrestrial ecosystem models (Fig. 2). For example, LPJ model rather shows positive anomalies in Far East Asia regions probably caused by positive precipitation anomalies.

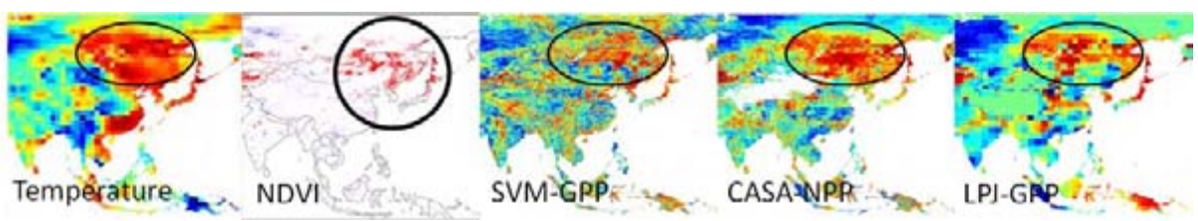

Fig. 1. Anomalies of Temperature, satellite-based NDVI and ecosystem model based GPP/NPP for Mar-May, 2002 from base period 2001-2006. Red and blue show positive and negative anomalies, respectively.

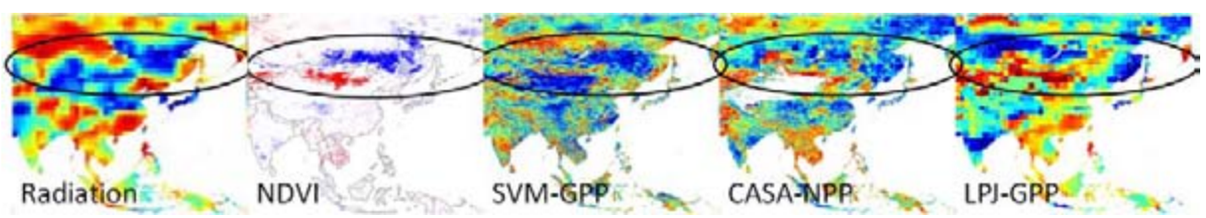

Fig. 2. Anomalies of Radiation, satellite-based NDVI and ecosystem model based GPP/NPPs for Jun-Aug, 2003 from base period 2001-2006. Colors are same as Fig. 1.

P117

ANALYSIS OF CLIMATE CONTROLLING FACTORS ON TERRESTRIAL GROSS PRIMARY PRODUCTIVITY: IMPLICATION FROM SATELLITE DATA AND ECOSYSTEM MODEL

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Poster I

Present estimation of terrestrial carbon cycle contains large uncertainties, therefore identifying key climate factors to control seasonal and interannual variations in vegetation productivities are important. Combination of multiple methods such as satellite based observation and ecosystem modeling is a powerful tool to understand them since each single method contains its biases. In this study, we analyzed interannual variabilities of climate variables, satellite-based vegetation index, and output of a terrestrial ecosystem model, LPJ-DGVM, to identify key climate factors to regulate terrestrial carbon cycle at a continental to global scale and analyze similarity and differences among satellite data and an ecosystem model.

We used time-series global climate data, satellite-based vegetation index data, and output of a terrestrial ecosystem model from 1984-2006. Climate data includes monthly CRU TS3.0 temperature and precipitation data and GISS incoming surface shortwave radiation data. Satellite-based data is from GIMMS NDVI data set after converting original 15-day and 8km resolution to monthly and 0.5 degree resolution. We used LPJ-DGVM as a terrestrial ecosystem model with running by the climate data from 1984-2006.

To analyze the climate controlling factor on vegetation productivity, we calculated correlation coefficient in each grid for annual and each 3-month season (Mar-May, Jun-Aug, Sep-Nov, and Dec-Feb). Correlation coefficient of NDVI and each climate factor, and LPJ-based GPP and each climate factor were calculated and historical trend of the changes were also analyzed.

Through the analysis of NDVI and climate relationship at an interannual time-scale, we found the following relations: (1) in the northern mid and high latitudes areas NDVI and temperature relationships are dominant in Mar-May (Fig. 1), (2) some regions shows high NDVI and radiation relationships in the northern mid and high latitude and tropical regions., and (3) NDVI and precipitation correlations in semiarid regions. These correlations are basically consistent with previous findings from satellite data. The similarity and differences among satellite-based NDVI and LPJ-GPP results implicate current capability of LPJ and its future requirement. Temperature responses are generally well simulated (Fig. 2); however, water and radiation responses should be further improved.

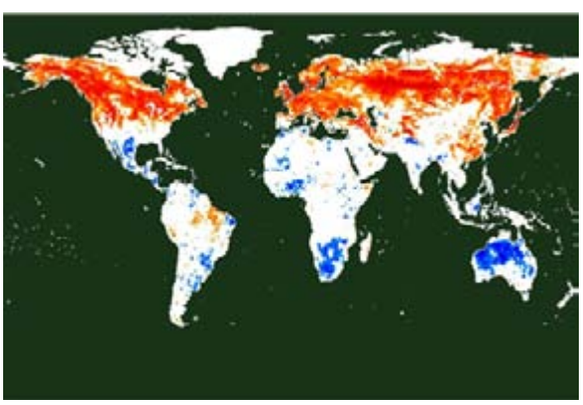

Fig. 1 Correlation of NDVI and Temperature in Mar-May from 1984 to 2006. Only pixels with statistically significant at 5% level are colored.

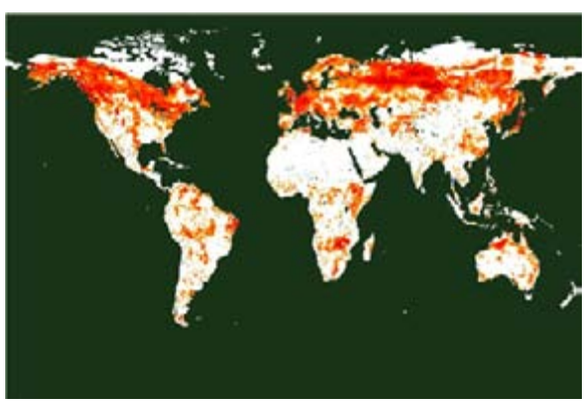

Fig. 2 Correlation of NDVI and LPJ-GPP in Mar-May from 1984 to 2006. Only pixels with statistically significant at 5% level are colored.

Poster I

P118

ASSESSMENT OF A TERRESTRIAL ECOSYSTEM MODEL USING FLUXNET OBSERVATIONS: TOWARD AN OBJECTIVE REFINEMENT PROCEDURE

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Future projections of global environmental changes based on earth system model show large uncertainties among models. One of the potential causes is uncertainties in terrestrial ecosystem modeling due to lack of sufficient validation works and systematic (objective) procedure of model parameter tuning. Thus, it is important to propose an objective refinement procedure. In this study, we established an objective ecosystem model refinement procedure by separating a model into independent sub-models and tested the procedure with over 50 Fluxnet observations.

We used simplified version of the MOSES2 land surface scheme and the TRIFFID dynamic vegetation model. These models are originally coupled to University of Victoria Earth System Climate Model; UVic ESCM, and we extracted the terrestrial sub-model. TRIFFID is a dynamic terrestrial vegetation model which simulated terrestrial ecosystem processes for five functional types (PFTs). The two models simulate the energy, moisture and carbon fluxes at the land surface at an hourly time step for each PFTs.

Through the default model run and assessment of model structure, we found the model overestimates evapotranspiration in winter (from snow sublimation) and underestimates gross primary productivity (GPP) for whole year, and summer peak net ecosystem productivity (NEP) for many sites. Therefore, we propose a procedure for model refinement: (1) snow sub-model, (2) water cycle sub-model, (3) GPP sub-model, and (4) respiration sub-model. Following the procedure, we assessed and refined. Required refinements were snow melting process, rooting depth, photosynthesis efficiency parameter, and temperature dependence of respiration. As a result of model refinements, the seasonal water and carbon cycle simulation has improved at most flux sites (e.g. Fig.1).

The advantage of this study is to make model refinement process more objective, to assess the model at over 50 flux sites, and potentially to include satellite-based observations. In future, we will integrate satellite-based observation such as snow cover, evapotranspiration, and GPP, and improve the dynamic vegetation sub-model and assess the impacts of terrestrial ecosystem model refinements on earth system modeling.

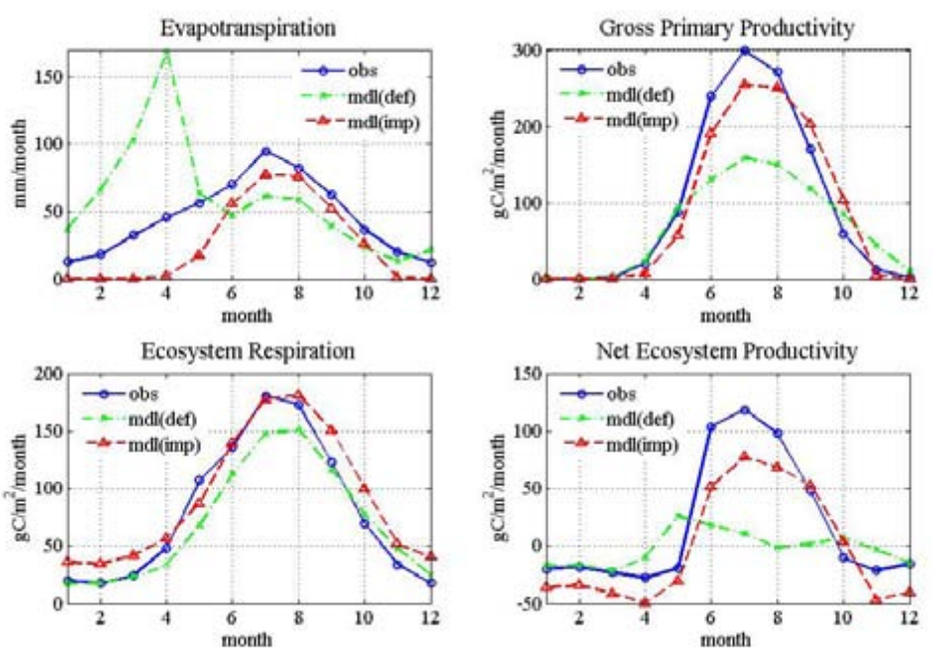

Fig. 1. Example of model refinements (Takayama, Japan, Deciduous Broadleaf Forest).

P119

ESTIMATION OF NET PRIMARY PRODUCTION IN BAMBOO ECOSYSTEM USING THE HARVEST METHOD

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Bamboo species are distributed throughout the tropics and warm temperate zones in the world. About 1200 bamboo species are known in the world. In Japan, there are about 600 bamboo species are known. *Phyllostachys pubescens* is one of the most major bamboo species in Japan. *Phyllostachys pubescens* was introduced from China about 400 years ago. *Phyllostachys pubescens* stands were maintained because bamboo species are used various situations. For example, culms are used for building material and handiworks, and also young shoots are edible. From 1970's, many bamboo forests were abandoned, because of the failed management of bamboo forests. As a result, abandoned bamboo forests invaded surrounding forests. Furthermore, vegetation of original forests changed to only bamboo species forests. Bamboo forests area of 2000's are about three times larger than that of 1950's. In this study, in order to clarify an influence of this shift in the forest vegetation, we estimated net primary production (NPP) of abandoned bamboo forest and maintained bamboo forest.

This study was carried out in a bamboo forest located in Gifu town, Gifu Prefecture, the central part of Japan (35°28' N, 136°45' E, 70 m above sea level) from 2005 to 2008. The study site is *Phyllostachys pubescens* forest and is about 5ha in area. This study site has been abandoned from 1990. In this site, we set up two research plot (maintained plot, abandoned plot). In each research plot, we estimated NPP of aboveground, rhizome, and root. NPP = ΔB+ Ln – Lo + G: ΔB, Ln, Lo and G are the amount of biomass increment, litterfall of the branch and leaf, dead part of each component and animal grazing. G is presumed to be negligible (G=0). The biomass increment (ΔB) and Lo were estimated based on the results of the inventory study. Ln was evaluated based on the results of litterfall. Mean annual air temperature and mean annual precipitation from 1971 to 2000 were 15.5 degrees and 1915.3mm at the weather station in Gifu town.

In the results of this research, at the maintained bamboo stand, the ΔB(above) of culm, branch and leaf were estimated at 7.57tC ha^{-1} $year^{-1}$, 1.21tC ha^{-1} $year^{-1}$ and 0.59tC ha^{-1} $year^{-1}$, each. At the abandoned bamboo stand, these were estimated at 5.24tC ha^{-1} $year^{-1}$, 0.82tC ha^{-1} $year^{-1}$ and 0.40tC ha^{-1} $year^{-1}$, respectively. Ln(branch) and Ln(leaf) at the maintained bamboo stand were 0.13tC ha^{-1} $year^{-1}$ and 1.66tC ha^{-1} $year^{-1}$. Ln(branch) and Ln(leaf) at the abandoned bamboo stand were 0.16tC ha^{-1} $year^{-1}$ and 1.89tC ha^{-1} $year^{-1}$. There were no Lo(culm, branch, leaf)at the maintained bamboo stand, because the standing density was controlled. The amount of Lo at the abandoned bamboo stand was 2.28tC ha^{-1} $year^{-1}$ for culm, 0.42tC ha^{-1} $year^{-1}$ for branch and 0.19tC ha^{-1} $year^{-1}$ for leaf. The aboveground NPP was 11.16tC ha^{-1} $year^{-1}$ at the maintained stand and 5.72tC ha^{-1} $year^{-1}$ at the abandoned stand. Furthermore, we tried to estimate NPP of rhizome and root, because *Phyllostachys pubescens* has a lot of rhizome. With regards to NPP of rhizome and root, Ln and Lo were presumed to be negligible (NPP = ΔB). At the maintained bamboo stand, NPP of rhizome and root was 1.10tC ha^{-1} $year^{-1}$ and 0.80tC ha^{-1} $year^{-1}$. NPP was estimated 0.62tC ha^{-1} $year^{-1}$ for rhizome and 0.54tC ha^{-1} $year^{-1}$ for root at the abandoned bamboo stand. Total NPP was 11.16 tC ha^{-1} $year^{-1}$ at the maintained bamboo stand and 5.72 tC ha^{-1} $year^{-1}$ at the abandoned bamboo stand. Compare NPP of these two stands, NPP at the maintained bamboo stand was twice as large as the abandoned bamboo stand.

P120

A SENSITIVITY ANALYSIS OF A TRIFFID-MOSES COUPLED DGVM TO BIOPHYSICAL CHARACTERISTICS IN A DECIDUOUS FOREST

Jihyeon Jang[1], Jinkyu Hong[1] and Joon Kim[1]

[1] Department of Atmospheric Sciences, Yonsei University, Seoul, Republic of Korea

Land surface models are widely used to predict the exchange of energy, water, and carbon. As the parameterizations within the land-surface scheme become more complicated for a realistic simulation, the number of model parameters may increase significantly. Some of the biophysical parameters can be directly measured, but the parameters which cannot be obtained from measurements need to be estimated empirically or calibrated by measured flux data. Since model parameters are variable depending on the estimation methods, highly sensitive parameters should be identified by the sensitivity analysis for a better model performance. In this study, a sensitivity analysis for key model outputs (e.g. heat and carbon fluxes) of a stand-alone version of this land-surface scheme, TRIFFID-MOSES coupled DGVM, was performed for biophysical parameters at a deciduous forest site in Korea. The simulation suggested that most influential parameters are the light-limited quantum efficiency(α) and the maximum carboxylase activity (V_{cmax}) of which the more limited parameter determines the photosynthetic rate. In addition, the outputs are dependent on input vegetation variables such as the leaf area index (LAI) and fractional coverage for each plant functional types (PFTs). Accordingly, biases in predictions or errors in measurements of vegetation variables have important impacts on the model performance. To ensure and compare the importance of each parameter, the same analysis for various PFTs and regions will be conducted. Furthermore, the model sensitivity with respect to time-dependent variables such as meteorological driving data needs to be examined to improve the model performance.

Acknowledgements : This research was supported by grants (code: 1-8-3) from Sustainable Water Resources Research Center for 21st Century Frontier Research Program, the A3 Foresight Program of the National Research Foundation of Korea, BK21 Program of the Ministry of Education and Human Resources Development of Korea. This study was also supported by the project “Development of Carbon Cycle Model for Coupling to Earth System Model (II)” of the National Institute of Meteorological Research (NIMR) / Korea Meteorological Administration (KMA).

P121

ESTIMATION OF UNDERSTORY EVAPOTRANSPIRATION BY EDDY-COVARIANCE IN DECIDUOUS AND CONIFEROUS FORESTS

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Understanding the characteristics of evapotranspiration (ET) and its partitioning into evaporation (E) and transpiration (T) provide critical information on water cycle. The ET measured by eddy-covariance technique above the plant canopy (ET_O) includes plant transpiration, soil evaporation, and evaporation from intercepted rainfalls. Especially over a tall vegetation (e.g., forest), the contribution is not only from overstory vegetation but also from understory vegetation. The ET from understory vegetation would be small or negligible if overstory vegetation is uniform and dense (e.g., closed canopy). Otherwise, the contribution from the understory ET (ET_U) can be significant.

In order to evaluate the relative contribution of ET_U to ET_O, we conducted the measurement of ET_U using the low-level eddy covariance towers under the two different forests (i.e., deciduous and coniferous forests) in the Gwangneung KoFlux site in Korea. The deciduous forest is a natural forest and its canopy structure and distribution are rather heterogeneous over a complex terrain. On the other hand, the coniferous forest is a plantation forest located in a relatively flat terrain, and its canopy structure and distribution are less heterogeneous. In this presentation, we will present the magnitudes of ET_U and examine the patterns of ET_U and the relationship between the ET_U and the seasonality of canopy structure at the different forests.

Acknowledgment. This study was supported by a grant (Code: 1-8-3) from Sustainable Water Resource Research Center of 21st Century Frontier Research Program, the Long-term Ecological Study and Monitoring of Forest Ecosystem Project of Korea Forest Research Institute, the Eco-Technopia 21 Project of the Ministry of Environment, A3 Foresight Program of National Research Foundation of Korea, and the BK21 Program from the Ministry of Education, Science and Technology of Korea.

P122

MEASUREMENT OF SOIL CO_2 EFLUX IN TEMPERATE DECIDUOS FOREST WITH AUTOMATIC OPEN/CLOSING CHAMBER SYSTEM

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[2] Division of Forest Ecology, Korea Forest Research Institute, Dongdaemun-gu, Seoul 130-712, Korea.

[3] Department of Atmospheric Sciences, Yonsei University, Seodaemun-gu, Seoul 120-749, Korea.

We investigated the soil CO_2 efflux at the forest floor in a mixed deciduous forest (*Quercus serata* , *Carpinus laxiflora* and *Carpinus cordata*) at Gwangneung KoFlux site in Korea. Our objectives were to quantify annul and seasonal variations of soil CO_2 efflux, and to investigate the effects of daily and seasonal variations of soil temperature and soil water contents on soil CO_2 efflux. In order to measure the soil CO_2 efflux, we used Automatic Open/ Closing Chamber system(AOCC) that based on an open-flow dynamic method. For five yeas, seasonal and annual variations of soil CO_2 effluxes were highly dependent on changing of soil temperature. Soil CO_2 efflux maintained the minimum value during winter between January and March and gradually increased since April. With large increase since June, the maximum value of 975~1,166 mg CO_2 m^{-2} h^{-1} was observed during summer in July and August. Annual average soil CO_2 efflux in this period was 386 mg CO_2 m^{-2} h^{-1}. Seasonal changes in soil CO_2 efflux and soil temperature showed high correlation. In July and August when soil temperature is highest, soil CO_2 efflux showed the peak, and the minimum was shown between January an March when soil temperature is lowest. Annual changes in soil moisture showed low correlation with soil CO_2 efflux regardless of season. However, in case of summer with temperature between 15~22℃, changes in soil moisture influenced soil CO_2 efflux with occurrence of rainfall. Soil CO_2 efflux showed a temporary increase of 10~62% when it rained, and soil temperature had a tendency to decrease with rainfall.

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CARBON DIOXIDE EXCHANGE AT FOUR GRASSLAND SITES ACROSS JAPAN AND INFLUENCE OF MANURE APPLICATION ON ECOSYSTEM CARBON BUDGET

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Grass is very important for live stock because the yield of grass occupies 85 % of forage crops in Japan. Recently, manure application is recommended in order to recycle the excrement as the countermeasure of this problem. However, it is feared that manure application makes N_2O and CH_4 release increase, or discharge nitrogenous compounds to surrounding area. On the other hand, manure application is expected to increase carbon stock in farm land but decomposition rate should change simultaneously. GHGG-Japan (Green House Gases of Grassland in Japan) project has established a network of four flux tower sites of grassland in Japan which cover from warm temperate region to cool temperate region. Each site has two plots: one plot is managed applied chemical fertilizer and the other is managed applied organic manure fertilizer. Eddy covariance system has been installed at both plots in four grassland site. In this study, we investigate the effect of manure application on carbon balance of grassland by comparing the two different managed plots among four sites.

Study sites were four grasslands: Nakashibetsu (NKS), Shizunai (SZN), Nasushiobara (NSS) and Kobayashi (KBY), which distributed from northern to southern Japan covering cool temperate and warm temperate region. There were two plots in each site; one is chemical fertilizer plot (C-plot) and other is manure plot (M-plot). We measure CO_2 flux using eddy covariance method, and calculated net ecosystem production (NEP) by adding CO_2 storage. Moreover, we estimated net biome production (NBP) by subtraction of harvest (H) from NEP. We calculated GPP and RE by semi-empirical model using PPFD and air temperature. We also estimated heterotrophic and autotrophic respiration (RH and RA) from carbon balance equation using eddy fluxes and biometric data.

Both NEP and NEB did not show linear relationship between air temperature whereas GPP and RE indicated strong linear relationship. NEP of all year and all plots expect for M-plot of KBY showed positive values and grassland ecosystems were carbon sink. Annual NEP of C-plot M-plot were distributed from 0.5 to 4.1 tC ha-1 y-1 and -0.8 to 2.0 tC ha-1 y-1, respectively. Both minimum and maximum values of annual NEP were found at same site: KBY site, which had large variations of NEP. Site-average annual NEP of C-plot M-plot were distributed from 1.3 to 3.0 tC ha-1 y^{-1} and -0.49 to 1.4 tC ha^{-1} y^{-1}, respectively. Consequently, all annual NEP of M-plot were smaller than those of C-plot.

All annual NBP of C-plot shows negative values, which were from -3.3 to -2 tC ha^{-1}. Site-average annual NBP of C-plot were distributed from -2.3 to -4.8 tC ha^{-1}. On the other hand, annual NBP of M-plot were larger than those of C-plot. Annual NBP of M-plot and site average annual NBP were from -2.3 to 4.8 and from -1.5 to 3.5 tC ha^{-1}. NBP of M-plot in two northern site (NKS and SZN site) were positive, that in temperate site was carbon neutral, and that in warm temperate was negative.

We discuss the effect of manure application on respiration. We assume that manure application stimulate RE. RE of M-plot were larger than those C-plot whereas RE of C-plot was larger than that of M-plot in SZN site. RA increased with annual air temperature from 5 to 23 tC ha^{-1} y^{-1}. In contrast, increase ratio of RH to temperature, which was distributed from 0.1 to 5.1 tC ha^{-1} y^{-1}, was smaller than that of RA. RH of M-plot were significantly larger than those of C-plot although there were no significant differences of RA between two plots. The reason is that soil organic carbon stocked by manure application and its decomposition should increase. In the summarized, manure application emphasized CO_2 release from organic matter; consequently, NEP of M-plot became smaller than those of C-plot. Although manure application emphasized CO_2, carbon stock increased.

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APPLICATION OF AUTOMATIC SLIDING CHAMBER FOR CONTINOUS MEASUREMERING NET ECOSYSTEM PRODUCTIVITY IN GRASSLAND ECOSYSTEM

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For better understand of carbon cycle dynamics of an agroecosystem, accurate determination of seasonal and daily CO_2 flux related to various environmental factors is required. We developed newly the automatic sliding canopy chamber (ASCC) system from principal of open flow method for measuring soil CO_2 efflux. The ASCC can measures continuously net ecosystem productivity (NEP) over full growing season under the natural meteorological rhythm. The ASCC is composed mainly two parts which is sliding part for measuring NEP, and automatic opening and closing chamber (AOCC) for measuring heterotrophic respiration (HR) on soil surface. In field test with barley (Hordeum vulgare), NEP was calculated with 78.2 mg CO_2 m^{-2} h^{-1} for full growth season, without any introducing measuring error due to the representative of measuring term selection. Also, the net primary productivity (NPP) calculated from NEP was 3.02 ton ha^{-1} for full growth period and it was similar to value in harvest method (2.81 ton ha^{-1}). Unlike other small scale chamber system, installation on cropping-field made it possible to pick any changes up which might be due to natural environmental condition.

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SOIL RESPIRATION IN NON-GROWING SEASON AND IT'S RESPONSE TO ENVIRONMENT FACTORS BASED MAIZE AGRO-ECOSYSTEM

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Based on continuous 3 years eddy correlation observe datum on maize agro-ecosystem non-growing season, Analysis result showed: the range of average day soil respiration in non-growing season was 1.08~4.08 g CO_2 m^{-2}. From the last November to follow February, the average month soil respiration were 66.18±5.15、69.29±7.75、66.96±2.01、59.76±10.10、64.03±10.80 and 80.24±5.90g CO_2 m^{-2}, respectively. From last October 16th to follow April 30th, the total soil respiration was 456.06±20.01g CO_2 m^{-2}. The trend of soil respiration in non-growing season appeared "U" type. The minimum value occurred in the latter 10 days in November. When the soil temperature beyond 0 ℃, the soil respiration was quadratic curve with soil temperature. Explain percents of three quadratic curve functions were 47%，38% and 70%, respectively. When soil water content beyond 10 %, the soil respiration was quadratic curve with soil water content. Explain percents of three quadratic curve functions were 36%，60% and 18%, respectively. However, coupling with the two functions can better predict the soil respiration. The model explain percent were 70%、53% and 79%, respectively. The predict value and observe value appear same trend pattern. The regress curve was match together with equal proportion line. The standard deviation were 10%，11.8% and 2.4%, respectively. Therefore, the function coupling soil temperature with soil water content can better offer maize agro-ecosystem non-growing soil respiration prediction.

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CHARACTERISTICS OF CO_2 FLUX BEFORE AND IN THE HEATING PERIOD AT URBAN COMPLEX UNDERLYING SURFACE AREA

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Abstract: Urban areas were significant contributors to global carbon dioxide emissions. The eddy covariance（EC） was use to measure carbon dioxide (CO_2) concentration and flux data at urban area in Shenyang. This research analyzed the characteristics of atmospheric CO_2 concentration and flux in October 2008 to November 2008 period before and in the heating period. The results showed that the daily variation of CO_2 concentration was two-peak curve. The first peak appeared time as same as sunrise time, while the second peak time appeared time impacted by vehicles and heating. The result of CO_2 flux showed that urban atmospheric CO_2 was net emissions, vegetation photosynthesis absorbed CO_2 of traffic, the CO_2 flux peak appeared at 17:15~18:15 in the heating period, CO_2 emission increased 29.37g•$(m^2d)^{-1}$ in the heating period than before the heating period; there was corresponding relationship between CO_2 flux and the time when temperature peak and sensible heating flux (Hc) turn positive.

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THE OPTIMAL COLOR INDEX FOR THE PHENOLOGICAL RECORDING OF LEAF CANOPIES

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Phenological observation is becoming increasingly important as climate warms and weather patterns become more extreme. Recently digital cameras ("webcams") have been placed on the existing network of flux towers to provide a time series of canopy images. The images vary depending on weather, illumination and setting of the cameras as well as the scene itself. There are many possible ways to process digital signals from these cameras (e.g. normalized intensities of RGB signals, vegetation indices, alternative color models), and it is unclear which of these is best for tracking phenological stages in forest ecosystems. The Phenological Eyes Network (PEN), a network of ground observatories, mounted a digital camera on the top of Mt Tsukuba, Japan (36°13'30"N, 140°5'52.8"E, 868 m above sea level) in autumn 2007 to capture the seasonal change of a temperate forest. Using simple images of a Japanese beech *Fagus crenata* we calculated 12 color signals and vegetation indices and compared their seasonal patterns through a year. A small number of them show clear signals and minimal 'noise'; hue is especially good to distinguish canopy changes during the vegetative period, but over the whole year an index based on green and red performs the best.

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INFLUENCE OF THINNING ON MICROWAVE BACKSCATTERING USING THE AIRBORNE SYNTHETIC APERTURE RADAR AT A LARCH FOREST IN TOMAKOMAI, JAPAN

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Recently, the polarimetric observations of microwave using the airborne and space-borne synthetic aperture radar (SAR) have been performed with high spatial resolution, whcich enabled us to detect topological changes in the land surfaces by means of remote sensing. Also, SAR possibly retrieves changes in land covers, such as structural change in vegetation canopy due to plant growths or cutting down of trees. In order to explore the applicability of SAR for terrestrial monitoring, it is required to make clear the relation between the rate of microwave scattering and the shapes and scales of various factors in the surfaces.

We investigated the microwave backscattering in the case of the structural change in forest canopy due to thinning at a larch forest in Tomakomai (42°44′N, 141°31′E), which is located in northern Japan. Annual mean temperature is about 7.4°C and annual precipitation is about 1055 mm. The mean canopy height was about 13.8 m. The topography is closely flat and its gradient is about 1- 2°.At this site, the fully polarimetric L-band (1.27 GHz) backscattering coefficients (σ^0) were measured using the airborne SAR by Japan Aerospace Exploration Agency during the periods from 2002 to 2005. The study areas were compartments from No. 1196 to No. 1198 in the experimental forest. The areas of each compartment were 28.36 ha at No. 1196, 27.80 ha at No. 1197, and 34.64 ha at No. 1198.

The value of σ^0 showed apparent seasonal variation, which had maximum peak in summer and minimum in winter. During the period from December 2003 to January 2004, the thinning was conducted at No. 1196 and No. 1197. The area No. 1198 was set as a control area, and the thinning was not applied. We evaluated how the effect of thinning was detected in σ^0 by comparing between the thinning area and the control area. At No. 1196 and No. 1197, the biomass was decreased by the thinning from around 110 ton/ha to around 80 ton/ha. At the event of thinning, small increase was observed in σ^0 of VV polarization, whereas σ^0 of HH polarization showed no apparent change. Here, H and V indicate the horizontal and vertical polarization, respectively. For instance, HV mean that the beam of H polarization is transmitted and the backscattered signal of V polarization is received.

We also evaluated the dependency of σ^0 on the incident angle and found that the larger zenith angle caused smaller σ^0. This angle dependency must be considered carefully, especially in the case of medium level of structural change in forest canopy at the event such as thinning.

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WET CANOPY EVAPOTRANSPIRATION IN A MOUNTAIN CLOUD FOREST

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Interception plays an important role in the hydrological characteristics of cloud forest ecosystems. Due to frequent and continuous wetness of the canopy, interception evaporation accounts for a high proportion of evapotranspiration from cloud forest. Studies at the Chi-Lan Mountain site[ii] (24°35'N, 121°25'E) indicated that upward water vapor fluxes were observed even during foggy conditions. However, the source of this evaporation water fluxes during foggy time and the heat energy sources have seldom been investigated.

In order to explore the evapotranspiration patterns under wet canopy conditions, two five-day intensive experiments were conducted at the Chi-Lan Mountain site from 2009/2/15 to 2009/2/19 and from 2009/7/14 to 2009/7/18, respectively. Eddy covariance method was applied to measure the net water vapor exchange between ecosystem and atmosphere. An open/closed-path eddy covariance system, including a sonic anemometer (Campbell CSAT3), an open path infrared gas analyzer (Licor LI7500) and a closed path infrared gas analyzer (Licor LI7000), was mounted at 1.8-fold of canopy height on the main meteorological tower. The S-type sap flow sensors (Ecomatik SF-L) were mounted at 1.3 m height of trunk on five representative *Chamaecyparis obtusa* var. *formosana* trees for the measurement of transpiration rate. Four leaf wetness sensors (Campbell LW237) and two infrared surface thermometers (Apogee IRTS-P) were added to monitor the wetness and surface temperature of canopy. Routine meteorological parameters, including visibility (measured by Mira 3544 visibility sensor), air temperature, relative humidity, soil water content, precipitation and radiation, were also measured through the experiment periods.

The result showed that both interception evaporation and transpiration were active during wet canopy conditions in summer and the main driving forces were incident solar radiation and vapor pressure deficit due to temperature gradient between leaf surface and surrounding air. In summer, fog typically formed in the afternoon and dissipated before midnight. Canopy surface was gradually wetted a few hours after the initiation of fog events. In the beginning hours of fog events in the late afternoon, canopy surface was only slightly wetted. Fog reduced radiation but canopy surface temperature was still warmer than surrounding air, transpiration contributed to water vapor fluxes at this stage. As fog persisted in the following nighttime, canopy surface wetness increased and only trivial water vapor fluxes were observed due to lack of energy for evaporation and the cease of transpiration. As incident radiation rose after dawn, leaf surface was heated, intercepted water over canopy surface was evaporated and canopy surface dry quickly in the morning. Both interception evaporation and transpiration contributed significantly to ecosystem water vapor fluxes during these drying periods till canopy surface was completely dry and transpiration dominated thereafter.

During winter time, cold frontal weather system usually lasted several days. The canopy surface at the Chi-Lan Mountain site was wetted the whole time and interception evaporation dominated the water vapor flux in such conditions. Solar radiation contributed less to canopy warming, and low interception evaporation was observed. Transpiration was only trivial to ecosystem water vapor fluxes during these continuously wet canopy conditions. After the end of cold frontal weather events, canopy surface remained wet till next dawn, canopy was warmed up again by increased incident radiation and transpiration gradually took place as canopy was drying up.

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[ii] More information about this site can be referred to http://metacat.ndhu.edu.tw/clm/

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INTEGRATED SYSTEM OF SATELLITE AND FIELD DATA FOR MAPPING OF GROSS PRIMARY PRODUCTION

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The Gross Primary Production (GPP, the total amount of CO_2 produced by photosynthesis) is one of the most important characteristics of the ecosystem. Continuous CO_2 flux measurements at a number of flux tower sites are useful for estimating the community scale GPP. At the larger scale upto global, the Moderate Resolution Imaging Radiometer (MODIS) onboard Terra and Aqua satellites have provided 8-day composite GPP at 1 km resolutions. Recently, some researchers suggest that the GPP is estimated from the Enhanced Vegetation Index (EVI) derived from satellite remote sensing data. The EVI was developed to optimize the vegetation signal with improved sensitivity in high biomass regions and improved vegetation monitoring through a de-coupling of the canopy background signal and a reduction in aerosol influences.

The GEO (Global Earth Observation) Grid is primarily aiming at providing an e-Science infrastructure for the earth science community. The GEO Grid is designed to integrate various kinds of data related to the earth observation using the grid technology, which is developed for sharing data, storage, and computational powers of high performance computing, and is accessible as a set of services. We have been developing a system for integrating satellite and field sensor data based on the OGC (Open Geospatial Consortium) Web service standards such as SOS (Sensor Observation Service), WPS (Web Processing Service), and so on. The first application of this system is the validation of the MODIS aerosol products (MOD08, the gridded atmospheric product) by ground-based measurements using the sunphotometer (skyradiometer, Prede POM-02) installed at Phenological Eyes Network (PEN) sites in Japan.

In this study, we show an integrated system of satellite and field data and discuss the application for the integrated analysis of the MODIS surface reflectance products (MOD09, atmospherically corrected product) with field measurements at flux tower sites in Thailand and Japan. The objective of this study is to construct the daily larger scale maps of GPP with a high degree of accuracy by the field measurement data and the EVI calculated from MOD09. The integration system on GEO Grid will become an effective tool for other integrated data applications.

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PHENOLOGY OF LEAF PHOTOSYNTHETIC PROPERTIES IN A COOL-TEMPERATE DECIDUOUS BROADLEAF FOREST IN TAKAYAMA, JAPAN

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Combined analysis of yearly NEP (net ecosystem production) by eddy covariance and NPP (net primary production) by biometric measurements showed that the interannual variability of NEP is mostly explained by the NPP in tree biomass, rather than those by NPP in foliage nor heterotrophyic respiration (Ohtsuka et al. 2009). This result suggests the possible influence of interannual variations in either the length of growing season, phenology and the yearly maximum of leaf photosynthetic capacity, which largely affects GPP (gross primary production). In present study, in order to reveal the phenological pattern and its interannual variation of the leaf ecophysiological properties, leaf mass per area (LMA), chlorophyll contents and photosynthetic capacity (light-saturated photosynthetic rate and hence the maximum velocity of carboxylation; V_{cmax}) were measured for *Quercus crispla* and *Betula ermanii* in Takayama site for six years. Leaf budbreak occurred in mid to late May, after two to three weeks of snowmelt, and the photosynthetic capacity increased gradually in *Quercus* but quickly in *Betula*. Photosynthetic capacity was largely correlated with chlorophyll contents throughout the growing season. Seasonal developmental rate, the timing of leaf photosynthetic maturation and its maximum values varied year by year. The developmental rates of photosynthetic capacity and LMA were estimated to be dependent on the time-series of the growing degree days (GDD), though the incident photosynthetic active radiation could have additional effect on the physiological development of leaves. We would plan to find the ecophysiological consequences among the leaf biochemical and morphological properties, by considering the remarkable influence of micrometeorological factors such as air temperature, light and water availability.

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EFFECTS OF SEASONAL AND INTERANNUAL VARIATION IN LEAF PHOTOSYNTHESIS AND CANOPY LEAF AREA INDEX ON CANOPY PHOTOSYNTHESIS IN A COOL-TEMPERATE DECIDUOUS BROADLEAF FOREST IN TAKAYAMA, JAPAN

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Revealing the seasonal and interannual variations in forest canopy photosynthesis is a critical issue to understand the ecological mechanisms underlying the dynamics of carbon dioxide exchange between the atmosphere and deciduous forests. This study examined the effects of temporal variations of canopy leaf area index (LAI) and leaf photosynthetic capacity (the maximum velocity of carboxylation; V_{cmax}) on gross primary production (GPP) of a cool-temperate deciduous broadleaf forest for five years in Takayama AsiaFlux site, central Japan.

We made two estimations to examine the effects of canopy properties on GPP; one is to incorporate the *in situ* observation of V_{cmax} and LAI throughout the growing season, and another considers seasonality of LAI but constantly high V_{cmax}. The simulations indicated that variation in V_{cmax} and LAI especially in the leaf expansion period had remarkable effects on GPP, and if V_{cmax} was assumed constant GPP will be overestimated by 15%. Monthly examination of air temperature, radiation, LAI and GPP suggested that spring temperature could affect the canopy phenology, and also that GPP in summer was mainly determined by the incoming radiation. But the consequences among these factors responsible for interannual changes of GPP are not straightforward since leaf expansion and senescence patterns and summer meteorological conditions influence GPP independently.

This simulation based on *in situ* ecophysiological research suggests the importance of intensive consideration and understanding of the phenology of leaf photosynthetic capacity and LAI to analyze and predict the carbon fixation in forest ecosystems.

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NEW METHOD FOR DETECTION OF VEGETATION PHENOLOGY WITH SATELLITE REMOTE SENSING: GRVI-METHOD

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Remote sensing of vegatation phenology, especially the timing of spring green-up and autumn leaf-coloring, is recently becoming more and more important to make a regional scale and long-term assessment of the effects of climate change on terrestrial ecosystem. A lot of methods for phenology detection by using satellite data have been already developed. Generally, the timing of phenological events is detected by tracking the time-series of NDVI (Normalized Difference Vegetation Index) which is calculated from visible-red and near-infrared reflectance of the earth surface. However, the NDVI-methods have some drawbacks. For example, it is impossible to specify the NDVI threshold to detect the timing of autumn leaf-coloring and some methods affected by the noises due to snow and water on the ground (Nagai et al., submitted). Moreover, the uncertainty of phenology detection by these methods is still unclear due to lacking of ground validation.

In the previous study, we proposed new satellite-based phenology detection method called "GRVI-method" based on the continuous ground-observed datasets about spectral reflectance and webcam images at the various ecosystems by Phenological Eyes Network (PEN) in Japan (Motohka and Nasahara, 2008). GRVI (Green and Red ratio Vegetation Index) is one of the spectral vegetation indices, which is calculated from visible green and red reflectance. GRVI-method uses "GRVI=0" as the threshold to determine the timing of green-up and autumn-coloring. GRVI-method has the following advantages compared with other methods: (1) It is robust to noises due to snow and water on the ground surface. (2) It is able to detect the timing of both spring green-up and autumn leaf-coloring.

In the study, we applied GRVI-method to satellite data (Terra/Aqua MODIS) of Japan in 2001-2008. To check the results, daily webcam images taken at various places were used. The result was compared with the result of the conventional NDVI-midpoint-method (White *et al*., 1997) and the MODIS phenology product distributed by NASA (product name: MOD12Q2).

As a result, GRVI-method showed consistent results with the actual timing of green-up and autumn-coloring observed by webcam images. NDVI-midpoint-method detected the timing of snowmelt rather than leaf development in snowy areas in spring and could not detect the autumn leaf coloring in most parts of Japan. MOD12Q2 product showed the timing of leaf development earlier than the actual and the timing of leaf coloring later than the actual. Moreover, there are a lot of null(no data) pixels in the MOD12Q2 product, especially in snowy areas. Therefore, it is considered that GRVI-method can provide us with the proper information about vegetation phenology in Japan.

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ESTIMATION OF CARBON BUDGET OVER BLACK SPRUCE FORESTS IN THE NORTH AMERICA USING TERRA/MODIS DATA

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1. Introduction

The recent global warming has occurred remarkably in the Circumpolar Region, and affected to the water and carbon cycles in the high-latitude ecosystems. In this study, the exchange of CO_2 in the sub-arctic forests was estimated by a satellite-based empirical model with the Terra/MODIS data, and the results were compared with the ground-based observation of exchange of CO_2 at two sites in the sub-arctic forests. This result will be used to estimate the regional carbon balance of high latitude forests in North America.

2. Method

In the present study, we calibrate and validate the satellite-based empirical model (Kitamoto et al., 2007; Date et al., 2009) for black spruce forest by applying 8-day products of Terra/MODIS. The forest widely distributed in the northern part of North America.

The model empirically infers gross primary productivity (GPP) from normalized difference vegetation index (NDVI) obtained from Terra/MODIS at 8-day time scale, where potential photosynthesis is constrained by radiation by ISCCP-FD, and air temperature by NCEP/NCAR.

The ground observation data acquired at two black spruce sites; Fairbanks, Alaska (64°52N, 147°51W) and the Northern Study Area of BOREAS, Canada (55°42N, 97°48W). The data of the Fairbanks and BOREAS site was used for the model calibration and validation, respectively. The data of 4 years from 2003 to 2006 were used.

3. Result

Seasonal variations of GPP by the model and the observation were compared in Fig.1. The model reasonably reproduced the seasonal cycle of the observed GPP in both Fairbanks and BOREAS in 2003. Though the difference is seen between GPP by the model and the observation at the start and the end of the growth period, the result in the present study has enough accuracy. The cumulative GPP of Fairbanks and BOREAS is compared in Table.1. The difference between the cumulative GPP estimated by the model and the ground-based observation was within about 10% in both sites of Fairbanks and BOREAS. It is thought that this result has enough accuracy. However, further model calibration should be required in future study.

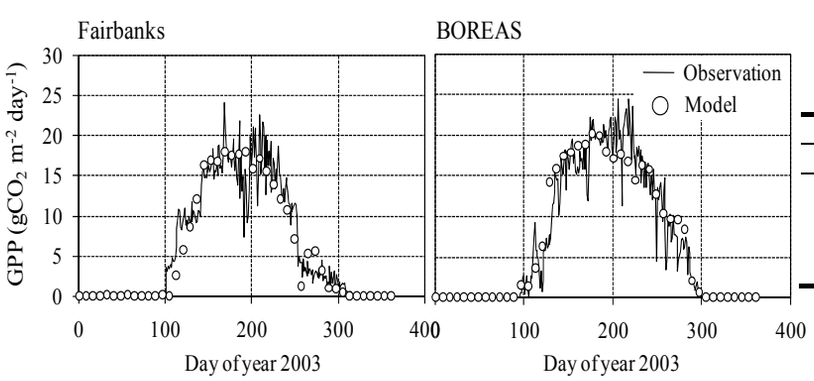

Fig. 1 Seasonal variation of GPP in 2003

Table. 1 Cumulated GPP

(gCO_2 m^{-2} $year^{-1}$)

	Fairbanks		BOREAS	
year	Obs	Model	Obs	Model
2003	2223	2102	2539	2594
2004	2156	2158	2284	2277
2005	2043	2255	2556	2788
2006	2407	2144	2864	2789

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USE OF DIGITAL CAMERAS FOR OBSERVATION OF VEGETATION PHENOLOGY

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Vegetation phenology is strongly tied to global carbon exchange and climate changes. Although satellite remote sensing has been used as a major method for phonological observation, this method has limitations in temporal and spatial resolution. In order to improve its accuracy, ground truth data are required.

In recent years, digital cameras and webcams, which can deliver imaginary information worldwide through internet web pages, have become technologically advanced and prevalent. By constructing networks of these web cameras for phenological observations, we could derive knowledge on ecosystem responses around the world.

In this study, we tried to detect phonological changes in vegetation captured in digital images by analyzing a large volume of digital camera images archived in "Internet Nature Information System" (by Ministry of Environment; http://www.sizenken.biodic.go.jp/). The images have been taken for seven years by standard digital cameras installed in the National Parks across Japan.

Here we introduce the case studies at Sarobetsu Plain (in Hokkaido) and other few sites in Japan, which cover various types of vegetation such as grasslands, deciduous broadleaved or coniferous forests, and a evergreen forest. Pixel values of each of visible RGB (red, green, and blue) component were extracted from JPEG format images, and then an index for vegetation greenness was calculated for each pixel.

The greenness index showed clear seasonal variations reflecting the timing of snow melt, leaf flush, leaf color change and defoliation at each site. Moreover, year-to-year variations or anomalies of seasonal patterns were observed from the index values. We also detected the physiological damage due to a severe typhoon and the changes in plant species composition. We demonstrated that analyzing large volume of archived images in a semi-automatic process is a potential method to detect the phonological changes much more easily and objectively then the conventional manual methods. After standardization of camera specifications and analysis algorisms, digital camera networks could be effectively used for long-term global ecosystem monitoring.

Poster I

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EVALUATION OF MODIS EVAPOTRANSPIRATION ALGORITHM AT THE EAST ASIA

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Evapotranspiration (ET) is one of major hydrologic processes of terrestrial ecosystem. Reliable estimation of ET over large area is necessary for understanding regional water budget, primary productivity of vegetation, and feedbacks of land surface to regional climate. MODIS (moderate resolution imaging spectroradiometer) provides an opportunity to monitor ET for wide area in daily time scale. In this study, we applied a MODIS-based ET algorithm proposed by Jang et al. (2009) and tested the reliability for nine flux tower sites in the East Asia. This is a stand-alone MODIS algorithm based on Penman-Monteith equation and uses input data derived from MODIS. Instantaneous ET was estimated and then, scaled up to daily ET. The MODIS-derived instantaneous ET showed good agreement evaluated with 6 flux sites (r^2=0.38 to 0.73, ME= -43.9 to +30.6W m^{-2}, RMSE= 47.8 to 111.4W m^{-2}). However, the other 3 sites showed poor. Also, extending result by daily ET is good agreement (r^2= 0.48 to 0.89, ME= -0.65 to -0.59mm day^{-1}, RMSE= 0.50 to 1.10mm day^{-1}). Errors in canopy conductance were identified as a primary factor of uncertainty in MODIS-derived ET and hence, more reliable estimation of canopy conductance is necessary for enhancing accuracy of MODIS ET.

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MONITORING OF THE GROSS AND NET PRIMARY PRODUCTIVITY IN EAST ASIA USING THE MODIS IMAGERY.

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Monitoring of global or regional changes in carbon cycles between the atmosphere and biosphere related to the terrestrial carbon sequestration is an important task necessary for the improved projections of future atmospheric greenhouse gases associated with the ongoing global warming. Remote sensing imagery allows us to examine the terrestrial biophysical processes across the broad regions compared with the point *in-situ* observations, but there are many challenges in accurately capturing the terrestrial processes using the remote sensing techniques due to many interrupting factors, including fickle weather conditions and land cover changes, as well as to the capabilities of remote sensors. In this study, spatial patterns of the cumulative annual Net Primary Productivity (NPP) and seasonal progressions of the Gross Primary Productivity (GPP) across East Asia derived from the NASA EOS Land Processes Distributed Active Archive Center (LP DAAC)'s MODIS Aqua products are examined for the period from 2002 and 2006. Composite maps of annual NPP over the study period confirm that the distribution of the NPP in East Asia is primarily determined by latitude and proximity to oceans. High annual NPP exceeding 3,000 kg C m^{-2} $year^{-1}$ is observed in the coastal regions adjacent to the northwest Pacific, while relatively low NPP below 1,000 kg C m^{-2} $year^{-1}$ is detected in the fringes of the extratropical deserts located in northwest China. The examination of individual annual NPP anomalies demonstrates that large differences between the NPP high and low years are observed in the border regions between the northwest Pacific and the Asian continent. These results suggest that the LP DAAC's annual NPP products should be used with cautions due to the contamination originated from non-biophysical parameters such as clouds, particularly in the East Asia monsoon regions where seasonal stationary rain front systems such as Biau (Japan), Changma (Korea), Meiyu (China) prevail. In this study, seasonal progressions of the carbon sequestration processes represented in the MODIS products will also be discussed based on the 8-day GPP data sets. These discussions will help the current algorithms of the terrestrial biophysical variables extracted from the satellite imagery improved at regional scales.

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SPRING CANOPY PHENOLOGY OBSERVED BY PHENOLOGICAL EYES NETWORK (PEN) SYSTEM AT A DECIDUOUS BROADLEAF FOREST, KOREA

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Satellite Remote Sensing is composed substantial methodology in the study of vegetation phenology but it is restricted by cloudy meteorological condition and frequent frosts. Phenological observation over near canopy top can hence provide continuous daily information on canopy development regardless of cloud and frost conditions. From March in 2009, we started a new phonological observation at a deciduous broadleaf forest, Gwangneung flux tower site, using "Phenological Eyes Network" System that was originally developed by K. N. Nasahara. The PEN system includes two ADFC (Automatic-capturing Digital Fisheye Camera) and one HSSR (Hemi-Spherical Spectral Radiometer). ADFC captures images of canopy and HSSR measures both incoming and reflecting radiation with a single radiometer. The digital images and spectral reflectance from March to June, 2009 were analyzed to investigate springtime canopy phonological change. Vegetation indices were derived and compared with NDVI, EVI, and NDWI from MODIS09 daily spectral reflectance products. We confirmed seasonal changes of vegetation indices and good agreement with MODIS-derived indices. We will discuss comparisons of spring vegetation phenology detected by different methods and spatial scales.

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EVALUATION OF METHANE FLUX IN A TEMPERATE LARCH FOREST BASED ON THE FLUX MEASUREMENTS AND INVERSE METHOD

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Methane (CH_4) is a powerful greenhouse gas, whose greenhouse effect is about 16% next to CO_2, and it is thought to be important in the global carbon cycle. Previously CH_4 was thought to be only produced under an anaerobic condition such as paddy field and wetland; however recent studies proposed that plant leaves emit CH_4 under an aerobic condition (Keppler *et al.*, 2006); the expected emission is about 30% of total global CH_4 emission. Thus, evaluation of CH_4 exchange in forest ecosystem is an urgent issue for global greenhouse gas prediction. In this study, we have conducted continuous observation of CH_4 flux in a temperate larch forest by using a relaxed eddy accumulation (REA) and modified gradient methods with a CH_4 profile measurement. With the profile data, we infer CH_4 flux near the forest floor with an inverse method based on a multi-layer model coupled with a second order turbulence closure model (Kishiara *et al.*, 2006).

Measurements have been conducted at the Fuji Hokuroku flux observation site located at the North foot of Mt. Fuji in Japan. The dominant tree species is Japanese larch (*Larix kaempferi* Sarg.) covering about 150 ha, and the canopy height is 20 ~ 25 m. The annual mean air temperature and total precipitation are 9.4°C and 1573 mm, respectively (CGER, 2006). A sonic anemometer and REA sample inlets were set at 35 m, whereas profile sample inlets were set at 35, 27, 16 and 0.3 m, respectively.

Primary result of CH_4 flux measured by the REA method is shown in Fig.1. The observation shows that the forest weakly absorbed CH_4 without the clear diurnal variation. According to the profile measurement (Fig. 2), this small absorption was mainly caused by the consumption in the forest soil, indicating that the leaves and trunks didn't mainly contribute to the canopy scale flux.

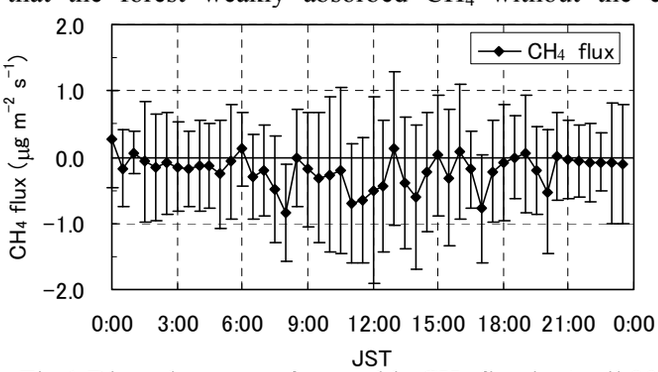

Fig.1 Diurnal pattern of ensemble CH_4 flux in April 2009.

Considering the observed results, we assume that the forest soil is a main contributor of the sink and source at canopy scale, and we inversely compute the CH_4 flux at the soil by the multi-layer model. First, we calibrate the diffusion coefficient near the soil surface with the temperature profile and soil heat flux. Then, we validate the inverse method with the CO_2 profile and CO_2 soil chamber data. The verified model will be used to estimate CH_4 flux at the soil and the total stand.

We will present the observed and computed results and the potential limitation. Based on our observation and modeling, we expect that the larch forest could act as a very small methane sink mostly in their soil during the study period.

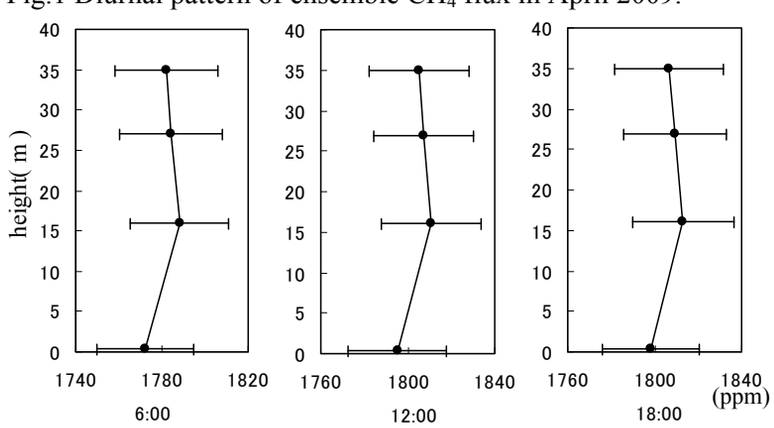

Fig.2 Ensemble means of CH_4 profile in April 2009.

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INTERSPECIFIC VARIATION IN EARLY SPRING SAP FLUX

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Basically all tree species use the same resources of light, water and nutrients. Thus each tree species develops different ecological strategies of acquiring resources to reduce competition. One of those strategies is differences in timing of acquiring resources. Especially in spring, water is most requiring resource to recover xylem embolism or cavitations and begin phenology. To investigate variations in water use of different species in early spring, sap flux was measured with thermal dissipation probe method. Measurements were taken in three Konara oak (*Quercus serrata*) and three laxiflora hornbeam (*Carpinus laxiflora*) of mixed deciduous forest in Gwangneung research forest from April to June 2009. Sap flux of both species increases with leaf expansion but daily sap flux values are highly fluctuated with environmental variables. Maximum differences in sap flux pattern between two species were appeared in early April. Sap flux of *C. laxiflora* was higher than *Q. serrata* in those periods. In contrast, sap flux of both species showed similar pattern after late April. There results indicate *C. laxiflora* develops different water acquiring strategy with *Q. serrata* especially in early spring.

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PARTITIONING SOIL RESPIRATION IN A RUBBER PLANTATION ECOSYTEM

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Soil respiration plays an important role in carbon cycle of tropical rubber plantation. This research aims to study soil respiration (Rs) of rubber ecosystem in Thailand and its partitioning into autotrophic (Ra) and heterotrophic soil respiration (Rh) by using the trenching method. Soil respiration was investigated in at the Chachoengsao Rubber Research Station which located in Phanom Sarakham district, Chachoengsao province (13°41′N, 101°04′E). The observation site was planted with a monoclonal stand of rubber trees clone RRIM 600. The rubber trees are 15 year-old in 2009. Tapping for latex production began when the trees were 8 year-old. Soil respiration of rubber ecosystem was measured at 2-week-intervals by using a soil CO_2 flux system Model LI-8100 (LI-COR Inc., Lincoln, NE, USA) with a 20 cm survey chamber. Temperature (°C) and volumetric water content (%) of soil at a 5 cm of depth were measured simultaneously with soil CO_2 efflux. During study period, averaged soil CO2 efflux, soil temperature and soil volumetric content ranged from 1.53-10.41 µmol CO_2 $m^{-2}s^{-1}$, 25.31-28.64 °C and 6.4-31.05%, respectively. Soil CO_2 efflux were significantly lower in the trenched-plots compared to the control plots (Fig 1), suggesting a major contribution of root and associated rhizosphere to soil CO_2 efflux in this site.

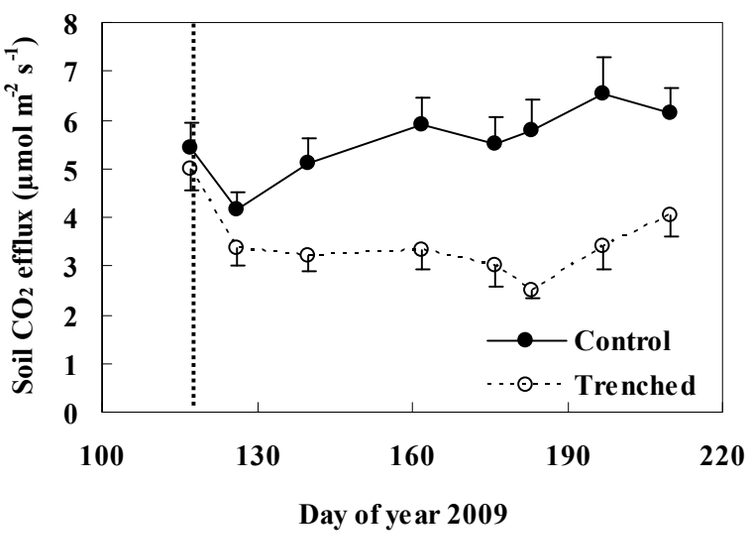

Fig. 1: Seasonal courses of soil CO2 efflux in control plots (closed circles, n = 24) and trenched plots (open circles, n=21). The dotted line indicates the trenching date and the vertical bars the confidence interval of the mean.

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THE CAFNET/COFFEE-FLUX PROJECT: EVALUATING WATER, SEDIMENT AND CARBON ECOSYSTEM SERVICES IN AN AGROFORESTRY COFFEE WATERSHED (COSTA RICA)

By O. Roupsard[1,2], F. Gómez-Delgado[1,2], B. Rapidel[1,2], R. Kinoshita[1,*], A. Perez[1], R. Moussa[3], C. Jourdan[1], G. Le Maire[1], J-M. Harmand[1], J-M. Bonnefond[3], P. Vaast[1]

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[*]Presenting author

"Coffee-Flux" is a sub-project of CAFNET (EuropAid/121998/C/G): "Connecting, enhancing and sustaining environmental services and market values of coffee agroforestry in Central America, East Africa and India." Coffee-flux was launched in December 2008 in Costa Rica by Cirad, CATIE, PCP and the Aquiares farm.

The aim of Coffee-Flux is to scientifically evaluate the water, sediment transport and carbon sequestration environmental services at the scale of an arabica coffee watershed. Experimental, modelling and remote-sensing approaches are combined. The project will last for several years from 2009, in order to encompass seasonal and inter-annual fluctuations of coffee productivity and environmental services.

Site and infrastructure description

A 1 km^2 coffee watershed, homogeneously shaded with tall *Erythrina poeppigiana* was selected in Aquiares, one of the biggest coffee farm of the country ("Rainforest" certified, located on the slopes of the Turrialba volcano, ranging in elevation from 1,020 up to 1,280 m.a.s.l., strongly influenced by the climatic conditions of the Caribbean hillside, without clear dry season). The watershed is already instrumented with automatic flumes, pluviometers, soil moisture probes, piezometers, turbidimeters and eddy-covariance tower (for H2O and CO2 gaz fluxes).

Monitoring of environmental services

Hydrological service assessment: Coffee-Flux is monitoring the water balance partitioning (rainfall, interception, superficial runoff, infiltration, soil water balance, evapo-transpiration, aquifer fluctuations and total streamflow), and the sediment yield from plot to watershed. Also a ^{18}O isotopic tracing experiment in underway

Carbon service assessment : Coffee-Flux is monitoring the Net Primary Productivity (NPP: tree + coffee growth and mortality) above and below-ground (minirhizotrons), the Gross Primary Productivity or ecosystem photoynthesis (GPP), the ecosystem + soil respiration and the Net Ecosystem Exchange (NEE) which is the ecosystem C balance, using combined eddy covariance and growth+litter monitoring

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GEOGRAPHICAL AND YEAR-TO-YEAR VARIATIONS IN THE TIMING OF LEAF FLUSHING OF WINTER-DECIDUOUS FORESTS IN THE NORTHERN HEMISPHERE

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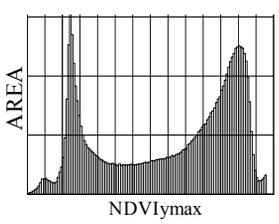
Leaf phenology, such as leaf flushing, foliation, leaf senescence, leaf discoloration (autumnal leaf coloration), contributes to the major characterization of the biospheric activity in forest ecosystems. The length of the growing or foliation period is an important determinant for estimating carbon exchange in cool-temperate deciduous forests. NDVI (Normalized Difference Vegetation Index) has been used as an indicator of vegetation activity. The onset of leaf flushing/discoloration was defined as the date when the NDVI values increased/decreased and crossed an appropriate threshold value in spring/autumn. Geographical and year-to-year variations on the dates of both phenological events were examined from the middle- to high latitudes in the Northern Hemispher, using the Pathfinder AVHRR NDVI dataset for every 10 day at a spatial 8 km resolution from 1982 to 2001, and MODIS NDVI dataset for every 8 day at a spatial 500 m resolution from 2001 to 2008. For the discontinuities resulting from satellite switch and trends by satellite orbit drift etc., we reprocessed the data to obtain a consistent NDVI time series in two steps. We created a histogram for a yearly maximum normalized vegetation index $NDVI_{ymax}$ which shows a distribution with two peaks for severe desert areas and areas with lush greenery. Original values for each year were transformed to standardized NDVI so that 2 peaks coincide with averaged peak values, respectively. This is nearly the same with standardization by maximum and minimum NDVI values. At next step, MODIS NDVI data were reprocessed by transformation parameter obtained by the comparison of pathfinder and MODIS data in 2001 when both NDVI existed.



The relationship between the daily observation of leaf phenology with an automatic camera system and NDVI in a cool-temperate deciduous forest at Takayama, Japan was constructed. By using a scaling up of the field data at Takayama toward the global scale, we estimate phenological events in the Northern Hemisphere. In order to obtain a spatial distribution of trends in the timing of leaf flushing, we performed a linear regression analysis at every pixel. In order to obtain a "qualitative sense" of the change in the timing of leaf flushing over a wide spatial scale (20-30% of all forest areas), we include in those regions showing trends with statistical significance of $P < 0.3$. The early/later onsets of leaf flushing occurred at the areas with unusually high/low air temperatures in the spring. We also performed a linear regression analysis for the spring air temperature (April and May). In order to assess how the trend varied over the 27-year study period, we divided the data into three nearly decadal periods: Period 1 (1982-1991), Period 2 (1992-2000), and Period 3 (2001-2008). During Period 1, many forests in the Northern Hemisphere showed earlier onset of spring leaf flushing (negative trend), probably because of conspicuous increase trend of spring temperature overall Northern Hemisphere. During Period 2, the delayed trend was found in North America due to with small temperature increase rate. In Period 3, onset of leaf flushing became earlier steadily as a rate of one day in 2-3 years. While, there was not clear trend of timing of leaf discoloration.

Period		N.Hemisphere	Eurasia	N.America
1982–1991	leaf flushing	−1.70 day/yr	−1.43	−2.14
	spring temperature	0.135 ℃/yr	0.093	0.204
1992–2000	leaf flushing	−0.61	−1.17	+0.35
	spring temperature	0.045	0.057	0.025
2001–2008	leaf flushing	−0.40	−0.34	−0.56
	spring temperature	0.047	0.031	0.084

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AN ANALYSIS OF LEAF PHENOLOGY USING A TIME SERIES OF FIXED VIEW CAMERA IMAGES - A CASE OF TROPICAL MONSOONAL EVERGREEN FOREST AT SAKAERAT, THAILAND -

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Using the numerical method to objectively detect seasonal variations of phenology of forest canopies by a series of daily fixed view photographs (Maeda and Gamo, 2004, JP Patent 4280823), the leaf phenology of the tropical monsoonal evergreen (dry evergreen) forest around the flux monitoring tower in Sakaerat (SKR), Thailand (14°29'33"N, 101°54'59"E) was analyzed. The applications to a cool-temperate deciduous forest in Japan (Maeda et al., 2005) and a tropical monsoonal deciduous forest in Thailand (Maeda et al., 2006, 2007) were already presented in the previous AsiaFlux workshops. In this presentation, a preliminary analysis done to confirm the feasibility of its application to an evergreen forest is presented. The photo images were taken at noon time every day by a fixed view digital camera with a fish eye lens placed on the top of the tower (about 40m high) looking down the forest canopy dominated by *Hopea ferrea* trees about 10m below. The photos taken in 2006-2008 were used in the analysis.

The photo images were processed to be made the time series of the normalized intensities (*r*, *g*, and *b*) i.e., the monochromatic intensities of respective channels of RGB averaged over the field of view, normalized by the average panchromatic intensity over the field of view. The area of the analysis in the photo and the seasonal variation of the normalized intensities *r*, *g* and *b* are shown in Fig. 1. While the drastic change of *r*, *g* and *b* due to the leaf shedding and emergence of new leaves in deciduous forests in Thailand (Maeda et al., 2008) appear during the dry season, the largest changes of *r*, *g* and *b* appeared in the middle of rainy season, around June, July, and August, in the dry evergreen forest. According to the observation of the photos and the in-situ observation, this is due to the emergence of the new leaves on the surface of the canopies and change of their colors associated with maturing process. The image analysis could detect these phenological events during the rainy season that could influence the photosynthesis efficiency and are difficult to detect by satellite vegetation indices due to the noise by the cloudy weather.

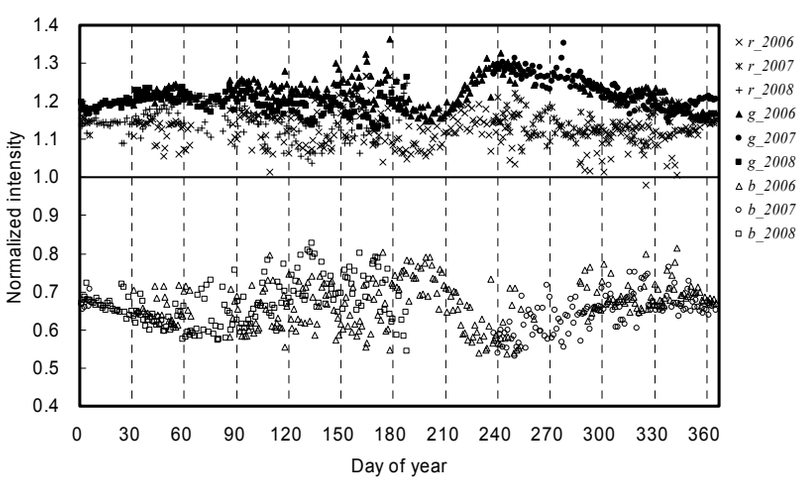

Fig.1. Seasonal variation of the normalized intensity for red (*r*), green (*g*) and blue (*b*) channels of averaged over the whole field of view of the images taken from the Sakaerat (SKR) flux monitoring tower in the dry evergreen forest during 2006-2008.

References: Maeda et al., Proceedings of AsiaFlux Workshop 2005(P06), 2006(P74), and 2007(P30).
Maeda et al., Proceedings of FORTROP II International Conference, 2008.

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WATER VAPOR AND PRECIPITATION ISOTOPE RATIOS IN BEIJING, CHINA

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The objective of this study is to investigate the characteristics of δD, δ^{18}O and deuterium excess (d) of precipitation and water vapor in surface air in Beijing, China. The δD, δ^{18}O and d of atmospheric water vapor in surface air were measured continuously with an in-situ technique. Much less day-to-day and diurnal variations in the vapor isotopic contents were observed in the summer monsoon season (June–August) than in the rest of the year. Outside the monsoon season, the vapor δD and δ^{18}O showed a log-linear dependence on the vapor mixing ratio and d showed a negative correlation with the local relative humidity (RH). Both relationships were statistically significant. The vapor mixing ratio and RH were poor predictors of the vapor isotopic temporal variability during the peak summer monsoon activities. Trajectory analysis suggests that the weak temporal variations in the vapor δD and δ^{18}O in the summer months were associated with regional recycling of atmospheric vapor. In addition, an analysis was presented of the interaction between the isotopic exchange between the vapor and the condensed phase. The δD and δ^{18}O departure from the equilibrium state was positively correlated with RH, and the d departure from the equilibrium state was negatively correlated with RH.

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ATMOSPHERIC NITROGEN DEPOSITION OF NSTEC FOREST ECOSYSTEM

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Atmospheric nitrogen deposition, one of the most important ways for forest ecosystem to receiving nitrogen, has increased sharply in resent years, for the artificial nitrogenous compounds emission dramatically raised as a result of industry and agriculture development. Therefore, atmospheric nitrogen deposition has been a new factor to impact the biogeochemical cycle of forest ecosystem, and causes a serious concern to ecologists. The North-South transect of Eastern China (NSTEC), including almost all forest types in china, is an ideal testing field to investigate the process of carbon and nitrogen cycling of forests which are influenced by Asian monsoon.

This study measured the atmospheric nitrogen deposition of typical forest ecosystems along NSTEC, and drew several conclusions: (1) in growing season, inorganic nitrogen deposition increased from 1.1 kg $N \cdot ha^{-1}$ at Huzhong deciduous coniferous forest to 12.5 kg $N \cdot ha^{-1}$ at Dinghushan subtropical monsoon evergreen broad-leaved forest from north to south; (2) in the north part of NSTEC, where the growing season is from May to October, inorganic deposition reached its peak in July, however, in the south part of NSTEC, where the growing season is all year long, nitrogen deposition showed two peaks in summer and winter; (3) NH_4^+_N accounted for more than 80% in the inorganic nitrogen deposition, and the organic nitrogen showed great fluctuation in total nitrogen deposition; (4) there was remarkable positive correlation between nitrogen deposition flux and precipitation, however, concentration of inorganic nitrogen deposition was decreased with increasing precipitation, well the reverse relationship was found between concentration of organic nitrogen deposition and precipitation; (5) nitrogen deposition flux in throughfall of coniferous forest was a little higher than that of broad-leaved forest, yet not statistically significant.

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SEASONAL CONTRIBUTIONS OF CARBON DIOXIDE AND WATER FLUXES OVER A REED MARSH IN NORTHEAST CHINA

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Wetlands are ubiquitous across the globe and are important to climate change because of their exchanges of energy and mass with the atmosphere. Knowledge of carbon dioxide (CO_2) and water (evaportranspiration, ET) fluxes in wetlands is crucial to estimate regional and global carbon and water budgets as well as to investigate global warming potentials. The contributions of non-growing season fluxes to the annual carbon and water budgets of a wetland are, to date, little studied. To address this issue, wetland-atmosphere exchanges of CO_2 and water vapour were measured, using eddy covariance method, in a reed marsh located in the Liaohe Delta, Northeast China for 3 years (2005-2007).

The marsh showed a net sink for atmospheric CO_2 in all years. The growing season CO_2 uptakes were of -157, -345 and -189 g C m^{-2} in 2005, 2006 and 2007, respectively, and 102, 114 and 136 g C m^{-2} were lost to the atmosphere for the 3 years, resulting in an estimated annual CO_2 budget of -55, -230, and -53 g C m^{-2} in 2005, 2006, and 2007, respectively. The cumulative CO_2 release during non-growing season was about 13-16% of the annual release, implying the importance of winter CO_2 efflux from this marsh. Maximum net CO_2 uptake (denoted negative) and release rates were -12.9 and 7.2 g C m^{-2} day^{-1}, respectively. The control factors of NEE varied among different temporal scales. Photosynthetically active radiation (PAR) controlled NEE on hourly scale, while temperature controlled it on daily and monthly scales. Temperature was a dominant control on ecosystem respiration (R_{eco}) on hourly, daily and monthly scales. R_{eco} increased exponentially with increasing temperature, and this relationship was affected by soil water content (SWC). When SWC (5cm) was 20-25%, the marsh has the greatest respiration potential.

Maximum daily ET rates ranged from 4.6 to 5.3 mm day^{-1}, occurring in mid-summer. Energy was the most important driver of ET over the reed marsh from hourly to monthly scales. Temperature could explain about 95% of the variation of monthly ET. With the downscale of temporal scale, the influence of vapour pressure deficit and relative humidity on ET became more important. Annual ET was about 432, 480, and 445 mm for 2005, 2006 and 2007, respectively. The cumulative ET during non-growing season was about 13-16% of the annual ET. It indicated the importance of winter ET, and it shouldn't be ignored in the calculation of annual ET.

Key words: Seasonal contribution, CO_2 flux, Water flux, Reed marsh, Northeast China

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DYNAMICS OF EVAPOTRANSPIRATION OVER GRASSLAND, MAIZE FARMLAND AND REED MARSH IN NORTHERN CHINA AND ITS SIMULATION

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At present, one of unresolved critical issues relating to climate change is whether evapotranspiration (ET) is increasing or decreasing with global warming. There has been great interest, therefore, in studying ET in a variety of ecosystems to better understand the nature of the controlling interactions and the links between ET and other ecosystem processes. Grassland, maize farmland and wetland are main ecosystems in Northern China, which play important roles in water exchange between land and atmosphere. ET is probably the process which responds more directly to climate forcing, and is related to the change in precipitation. The accurate estimation of water loss by ET is very important for assessing water availability and requirements of terrestrial ecosystems, and making proper water resources plans. Although lots of studies related to water vapor, heat and energy exchanges in individual terrestrial ecosystem had been carried out, there is still a need for better understanding of the processes controlling ET and its simulation of terrestrial ecosystems. Moreover, there are great differences of the surface properties between the cultivated farmland and natural ecosystems, which result in significant spatial discrepancies of ET, and provide a unique opportunity for examining and quantifying the impacts of environmental controls on ET. In this report, land-atmosphere exchange of water vapour was measured, using eddy covariance method, over grassland (*Stipa krylovii* steppe), rain-fed maize farmland and reed marsh in Northern China for 4 continuous years (2005-2008), in order to understand the differences in diurnal and seasonal scales and the primary controls on ET among different ecosystems.

Similar diurnal and seasonal variations of ET were found among grassland (*Stipa krylovii* steppe), rain-fed maize farmland and reed marsh in Northern China. Diurnal variations of ET at different phenological stages showed similar patterns, with small nocturnal values and peak values occurring around noon. Daily ET varied in response to the variations in the phenology. The ET increased rapidly once the leaves expanded and reached peak rates with the maximum leaf area index (LAI). Seasonal variations in ET had a similar trend as the seasonal patterns of LAI, net radiation (Rn) and air temperature (T). Maximum daily ET rates over the marsh ranged from 4.6 to 5.3 mm day^{-1}, occurring in mid-summer. Energy was the most important driver of ET over the reed marsh from hourly to monthly scales. Temperature could explain about 95% of the variation of monthly ET. The cumulative ET over the marsh during non-growing season was about 13-16% of the annual ET, indicating the importance of winter ET. ET was greater over maize farmland than over the grassland and the marsh, half-hour peak values of ET over the wetland delayed for half an hour compared to the maize farmland. The ratio of ET to potential ET (ETp) indicated that ET over the marsh was most of the time close to ETp in non-growing season, while ET over the maize farmland was closer to ETp in the growing season. A weak linear relationship was found between ET and leaf area index (LAI) over the reed wetland in the growing season, indicating that the transpiration from canopy provided few contributions to ET.

An evapotranspiration coefficient (K), defined as the ratio of actual ET from a certain vegetated surface to the reference evapotranspiration (ET_0) estimated from FAO Penman-Monteith equation, was suggested in order to evaluate actual ET based on common environmental variables. The regression analysis between K and environmental variables indicated that leaf area index (LAI), air temperature (T), relative humidity (RH), and net radiation (Rn) were the most explanatory variables for the day-to-day variation of K. However, the contribution of the control variables to K is different among different ecosystems. Based on these results, a daily ET model was developed from the FAO 56 approach, in which daily values of K was a function of LAI, net radiation, air temperature and relative humidity. The model was validated using long term flux observation data from 20 eddy covariance towers of terrestrial ecosystems in Northern China, in which it was found that the model agreed well with the observed data.

Key words: Water flux, Simulation, Grassland, Reed marsh, Maize farmland

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DEVELOPING AN INTEGRATED TERRESTRIAL MODEL OF VEGETATION DYNAMICS, ENERGY AND CARBON EXCHANGES AND BIOGEOCHEMICAL CYCYES IN COOL-TEMPERATE FOREST ECOSYSTEMS

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In the field of micrometeorological research flux tower measurements have been conducted worldwide to understand energy and carbon exchanges between atmosphere and biosphere. One can find numerous reports on near-surface energy and carbon exchanges between the atmosphere and terrestrial ecosystems on a stand scale over a decade and on a spatially large scale using meta-analysis in which flux data at multi-measured sites are utilized. One of current crucial issues is to predict accurately inter-annual variations in energy and carbon exchanges between the atmosphere and forest ecosystems under climate change in the future.

In forest ecosystems, inter- or intra-specific competition for light, water and nutrients leads to dynamic spatial and temporal changes in size structure and distribution of trees (frequency distribution of individual plant size, such as height, stem diameter and biomass). The dynamic changes in the plant population produce varying micrometeorological environments, and consequently, varying energy and carbon exchanges of the plant population. In addition, the nutrient cycle is determined by a result of internal cycling and retention of past inputs in the terrestrial ecosystem and is largely regulated by plant uptake, loss from the system, litter-fall and death of plants due to competition between inter- or intra-specific individual plants. To predict long-term variations in energy and carbon exchanges, biogeochemical cycling in forest ecosystems with vegetation dynamics, therefore, it is necessary to integrate the models developed for micrometeorology-vegetation dynamics and biogeochemical cycling in forest ecosystems.

In the presentation, we report comprehensively observed results obtained from the flux tower measurement, ecological and biogeochemical researches that have been conducted in cool-temperate forested watershed in Northern Japan which closes to the southernmost area of sub-boreal terrestrial ecosystem. In addition, we introduce future perspectives for developing a coupled atmosphere-vegetation-nutrient dynamics model in high-latitude terrestrial ecosystems that may be vulnerable to abrupt changes in climatic conditions. This challenge would be one of the representatives for the joint research strategy between Japan Flux and JaLTER (Japan Long-Term Ecological Research Network) to understand and predict the ecosystem responses to global climate changes.

The model development has been conducted as part of the primary research subjects of terrestrial research groups GCOE-IFES programs (PI: Dr. Yasuhiro Yamanaka) and Institute of Low Temperature Science), Hokkaido University, Japan.

Poster I

P150

SOIL CO_2 FLUXES IN SOUTHERN VIETNAM DURING DRY SEASON

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Vertical distribution of soil properties and soil CO_2 fluxes has been studied in southern Vietnam (Cat Tien National Park, located approximately 150 km north of Ho Chi Minh City) in six ecosystems during dry season (February, 2009). Cat Tien National Park consists of evergreen tropical and deciduous forest, dominated by Dipterocarpaceae, Fabaceae and Lythraceae (especially Lagerstroemia spp.), with 40% of the park comprising bamboo woodland, and the remaining 10% farmland, wetlands and grassland.

Soil CO_2 fluxes were measured by a closed chamber method using gas analyzer Li-Cor 820 (Li-Cor Inc., USA). Soil CO_2 fluxes were rated for soil covered tree waste and without it.

Soil was separated into layers and common descriptions of soil profiles to depth of 50 cm were made and soil moisture, soil temperature were measured after CO_2 fluxes were determined, soil properties, microbial respiration were identified in laboratory within few month.

Average soil CO_2 fluxes during period of measurements varied between 60 -180 mg C m^{-2} h^{-1}. The contribution of CO_2 because of tree waste decomposition in common soil flux was rated from 1 to 37%.

No relationship was found between soil temperature and CO_2 emission rates. The variability of soil CO_2 fluxes was mainly explained by soil moisture.

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EFFECT OF LAND USE CHANGE ON SOIL CARBON DYNAMICS IN TROPICAL REGION

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Tropical forests in Asia are rapidly being converted into secondary forests or plantations; deforestation to create permanent croplands has accounted for approximately 75% of the total CO_2 emissions from tropical Asia in the 1980s (Houghton and Hackler, 1999). Annual C flux to the atmosphere from changes in land use in tropical Asia was 0.88 Pg C y^{-1} during the 1980s and 1.09 Pg C y^{-1} during the 1990s (Houghton, 2003). Soil respiration, CO_2 efflux from the soil surface, is an important process of the carbon (C) cycle in terrestrial ecosystems. This land use change might strongly affect the global C cycle; nevertheless, few data are available to reflect land use effects on dynamics of soil organic carbon (SOC) in Southeast Asia. A process-based model, VISIT (Vegetation Integrative SImulator for Trace gases; Ito, 2008), was improved by incorporating disturbance processes such as vegetation conversion and residual soil decomposition. It was firstly applied to a tropical rain forest and oil palm plantation at Pasoh site, Malaysia (2°5′N, 102°18′W), after being calibrated with forest survey data. The oil palm plantation (*Elaeis guineensis*) around Pasoh area was established in 1976.

Seasonal field data suggest that the soil respiration rate is negatively correlated with soil water contents in the primary forest. The soil water content shows a negative correlation with the gaseous phase content. The gaseous phase content shows a positive correlation with soil respiration rate at both sites. The annual C efflux from soil in 2001 was estimated using field data as 18.1 t C ha^{-1} in the primary forest, and 14.4 t C ha^{-1} in the oil palm plantation. The result of model simulation was 18.3 t C ha^{-1} in the primary forest, and 15.3 t C ha^{-1} in the oil palm plantation. After land use changed, VISIT model indicated that soil respiration strictly decreased and has recovered with the growth of vegetation. According to field data, soil physical and chemical characteristics in oil palm plantation were different from primary forest. We discuss effect of changing soil characteristic on soil carbon dynamics using both of field data and model simulation in this presentation.

P201

BIOMASS CARBON STOCKS AND ITS POTENTIAL IN RUBBER PLANTATION IN XISHUANGBANNA, SOUTHWEST CHINA

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With the widespread land-use conversion from tropical rain forest to rubber plantation since 1970s, the Xishuangbanna region (1.9×10^6 ha) of southwestern China has likely reduced carbon stocks. To quantify this potential C sink changing and understand its implication to the regional carbon budget and future forest management, we selected 6 age series (5, 9, 14, 19, 23 and 26 a) of rubber plantation in suitable growing region (low elevation, 550-600 m) and unsuitable growing region (high elevation, 950-1050 m) to estimate changes in biomass carbon stocks in Xishuangbanna. The results showed that maximum above-ground total biomass were 205.82 $t\cdot ha^{-1}$and 139.76 $t\cdot ha^{-1}$ in suitable growing region and unsuitable growing region, respectively. The intrinsic rates of natural increase of rubber plantation in the suitable growing region and unsuitable growing region were 0.21 and 0.14, respectively. Above-ground net primary productivity (ANPP) of rubber plantation peaked in the 19-year-old stand in suitable growing region, was 16.22 ± 3.47 $t\cdot ha^{-1}\cdot a^{-1}$, however, ANPP was highest for the 23-year-old stand in unsuitable growing region, was 8.65 ± 3.46 $t\cdot ha^{-1}\cdot a^{-1}$. Total biomass carbon stocks of rubber plantation in suitable growing region and unsuitable growing region were 123.49 $tC\cdot ha^{-1}$ and 83.86 $tC\cdot ha^{-1}$, respectively, which were significantly lower than these in local tropical seasonal rain forest (311.41 ± 66.46 $tC\cdot ha^{-1}$). Total biomass carbon stocks of rubber plantation in suitable growing region was slightly higher than the average value of whole tropical rain forest in the world (121 $tC\cdot ha^{-1}$). By 2008, total biomass carbon stocks of rubber plantation in Xishuangbanna was 16.54×10^6 tC.

Poster II

P202

THE CARBON BALANCE OF A PRIMARY TROPICAL SEASONAL RAIN FOREST

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The role of primary tropical rain forest played in global carbon cycling is under active debate. Combined long-term forest inventory data with physiological measurement data of a 1 ha permanent ecological research plot beneath a eddy covariance flux tower in a primary tropical seasonal rain forest, the ecosystem carbon balance was investigated and a detail site-specific carbon cycle pattern was set up. The studied ecosystem was a carbon sink which be convinced both by eddy covariance (1.19 Mg C ha^{-1} yr^{-1}) and biometric method (3.59 Mg C ha^{-1} yr^{-1}). Biometric and eddy covariance based net ecosystem production shows no convergence in our investigation interval due to temporal and spatial discrepancy of this two approach. The relative large biomass increment due to relative fast annual growth rate of large trees was primarily accounted for the relative large ecosystem carbon sink derived from biometric method. High leaf respiration proportion in carbon allocation and low ecosystem carbon use efficiency (0.36) was observed in our site.

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CARBON STORAGE AND SOIL CO_2 EFFLUX OF TROPICAL SEASONAL RAIN FOREST，RUBBER TREE PLANTATION AND PADDY SOIL IN XISHUANGBNANA, SOUTHWEST CHINA

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Global change, with great impacts on natural ecosystems and human society, is a great concern of scientists, common people and governments around the world. The increasing CO_2 concentration in atmosphere, induced from fossil fuel burning and land use/land cover change, is one of the main factors related to global warming. The research on soil respiration and carbon sequestration in vegetation is important for understanding carbon cycle in terrestrial ecosystem.

Based on the biomass data from previous studies and the dada collected in this study, we estimated the carbon stock in the biomass of tropical seasonal rain forests, secondary forests and rubber tree plantation of different age. The carbon stock in the biomass of tropical seasonal rain forest was 180.46 tC hm^{-2}，and that of rubber tree plantation at the age of 7, 15, 22 and 40-year-old was 18.36, 75.36, 169.75 and 362.18 tC hm^{-2}, respectively. The mean carbon increase rate of rubber tree plantation was 7.78 tC hm^{-2} a^{-1}.

The carbon stock in the soil at the depth of 1m of tropical seasonal rain forest, 15-year-old rubber tree plantation and paddy soil was 80.1, 144.3 and 103.0 tC hm^{-2}, respectively.

The diurnal change of soil respiration rate of tropical seasonal rain forest was small, but the seasonal change was great, in relation to temperature, soil moisture and plant phenology. The annual CO_2 emission from soil, soil with litter, and soil with litter & seedlings treatment was 9.5, 12.7 and 14.6 tC hm^{-2} a^{-1}，respectively. Q_{10} value was 2.03, 2.36 and 2.08, respectively.

The soil respiration rate of rubber tree plantation changed seasonally, with no close relationship to temperature and soil moisture. The annual CO_2 emission from soil was 10.97 tC hm^{-2} a^{-1}. Q_{10} was 1.65 to 1.86.

The diurnal change of soil respiration rate and rice ecosystem respiration rate were obvious. In growing season, soil respiration rate and rice ecosystem respiration rate related negatively to depth of water. In the relative dry period before rice transplanting, soil respiration rate related positively to soil moisture. In the wet period after rice harvest, soil respiration rate was mainly affected by temperature. Q_{10} was 2.46 to 3.67. The annual CO_2 emission from rice ecosystem with normal nitrogen fertilizer dosage was 6.37 tC hm^{-2} a^{-1}. NEE was 2.24 tC hm^{-2} a^{-1}. This rice ecosystem served as a carbon sink.

We studied carbon flux in tropical seasonal rain forest by eddy covariance technique. NEE changed obviously at diurnal, seasonal and inter-annual scale. The temporal change of NEE was shaped by local specific climate and related plant phenology, balance between photosynthesis and plant respiration, soil respiration, litter decomposition, fine root decomposition. The result showed that the tropical seasonal rain forest in Xishuangbanna was a carbon sink from 2003 to 2006, and changed seasonally, as a carbon source in wet season (from April to August), a carbon sink in other seasons.

P204

A VALIDATION STUDY OF THE PRACTICAL CORRECTIONS FOR SENSOR HEATING AT OPEN-PATH IRGA SURFACES USING COMPUTATIONAL FLUID DYNAMICS

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Poster II

Open-path eddy covariance has been used in various ecosystems to measure surface CO_2 and H_2O fluxes. In AsiaFlux, almost half forest sites and 93% unforest sites use only the open-path system, where a commercial model (LI-7500; LI-COR) of open-path infrared gas infrared analyzer (IRGA) is extensively employed (Mizoguchi et al. 2009). Although the de facto standard sensor generally provides reliable density estimates of CO_2 and H_2O, some studies raise a question about the performance in particular conditions. Dusts on its optical windows changed offsets in both CO_2 and H_2O readings (Serrano-Ortiz et al., 2007). The sensor body acted as a heat source, which resulted in a miscalculation of the WPL correction (Grelle and Burba, 2007). Recently, a practical correction that compensates heat fluxes from the sensor body in the WPL terms was proposed (Burba et al., 2008). The correction is base on an underlying assumption that all of heats emitted from the body pass through the infrared path of the sensor. However, the assumption is rarely valid because emitted heats are subject to three-dimensional dispersion. The objective of this study was therefore to investigate the ratio of the heat from the surface to that at the infrared path in various wind conditions using the computational fluid dynamics (CFD) simulation. In the CFD simulation, the sensor head consisted of two bluff bodies, a sphere with a diameter of 49 mm and a cylinder with a diameter and height of 64 mm and 114 mm respectively, deployed vertically with a distance of 125 mm. The calculation volume was 1 m^3 and divided into approximate 150,000 meshes by a grading function so as to locate fine meshes near the objects. Lateral boundary conditions were not cyclic: wind velocity, TKE, hydraulic diameter and temperature were uniformly distributed at the inlet and a constant pressure outlet was used at the opposite side. Heat fluxes from the top and side surfaces of the cylinder were changed between 30 and 300 W m^{-2} and the ratio of the vertical heat flux at the infrared path to the total heat flux generated at the cylinder surfaces (H_{path}/H_{body}) was evaluated at different inlet velocities and TKEs. A commercial solver (Fluent 6.3; ANSYS) was used to solve the Reynolds-averaged Navier–Stokes equations. The ratio H_{path}/H_{body} was nearly constant under a particular wind and turbulent condition, suggesting that the Burba's equations, which principally predict H_{body} from meteorological variables, can be improved by simply including H_{path}/H_{body} as a correction factor to evolve H_{path}. H_{path}/H_{bod} logarithmically increased with TKE and exponentially decreased with wind velocity, which were likely parameterized separately. However, combining the reciprocal effects into a function was not performed. H_{path}/H_{body} ranged between 3% and 10% under possible weather conditions and H_{path} was expected to be 100 W m^{-2} at a maximum. The assumption, $H_{path}=H_{body}$, could overestimate the correction for the sensor heating.

P205

COMPARATIVE GAP-FILLING METHODS FOR EDDY COVARIANCE CARBON DIOXIDE FLUXES AT CHI-LAN MOUNTAIN FLUX TOWER SITE

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The approach that filtering nighttime eddy flux data with adequate u_* criterion was widely applied around flux sites to exclude data which were unable to represent the real net ecosystem exchange. For the Chi-Lan Mountain flux tower site(CLM, 24°35' N, 121°E), the most adopted u_*-correction method failed due to the lack of well defined pattern between the u_* (friction velocity)and the measured carbon dioxide fluxes. Several alternative approaches were tested in this study.

We applied maximum nocturnal ecosystem exchange (Rmax) and quantile regression (QR) methods. The estimated nighttime fluxes were used to establish nighttime respiration models. The estimated respiration was then compared with the daytime ecosystem respiration estimated through using the light response function and the daytime eddy fluxes. After applications all different gap-filling methods, the quantile regression was an easier method to solve flux data gap.

P206

POOLING OF CO_2 AND ITS INMPLICATIONS ON NET ECOSYSTEM CARBON EXCHANGE MEASUREMENT IN A PRIMARY TROPICAL SEASONAL RAIN FOREST

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Measurement of net ecosystem carbon exchange with micrometeorological method under complex terrain in tall forest stand is a challenge issue. We applied continuously measured eddy covariance and CO_2 profile data to addresses pooling of CO_2 and its effect on net ecosystem carbon exchange in a primary tropical seasonal rain forest which typically occurred in mountain valleys. Pooling of CO_2 in the bottom of valley was significant. "Carbon Lake", which similar with "cold air lake", was frequently occurred in the bottom of the valley under calm condition. On seasonal scale, the occurrence of "carbon lake" (with frequency > 0.60) was coincide with carbon source zone (April-September).

P207

NEW CO_2/H_2O GAS ANALYZER COMBINES THE ADVANTAGES OF OPEN-PATH AND CLOSED-PATH SOLUTIONS

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Open-path and closed-path designs of the fast CO_2/H_2O gas analyzers are well-established and widely used to measure concentrations and fluxes of carbon dioxide and water vapor. Both designs have their advantages and deficiencies. Open-path analyzers have excellent frequency response, long-term stability, and low sensitivity to window contamination. They are pump-free and require infrequent calibrations. Yet they are susceptible to data loss during precipitation and icing, and may need instrument surface heat flux correction when used in cold conditions. Closed-path analyzers can collect data during precipitation, can be climate-controlled, and are not susceptible to surface heating issues. Yet they experience significant frequency loss in long intake tubes, especially problematic when computing water vapor flux. They may require frequent calibrations and need powerful pump. Here we present preliminary data from third kind of a design: a compact enclosed CO_2/H_2O analyzer, the LI-7200, enabled for operation with short intake tube, intended to maximize strengths and to minimize weaknesses of both traditional open-path and closed-path designs.

Four prototypes with four different intakes were extensively field-tested in three experiments over two contrasting ecosystems in 2006-2009 to assess performance and power requirements of the instrument, and to determine its' optimal configuration. LI-7500 was used as a standard for carbon dioxide and water vapor concentrations and frequency response, and for water vapor flux. LI-7000 was used as a standard for carbon dioxide flux. All flux data were collected at a 10 Hz rate, and processed using standard FluxNet methodology.

Instantaneous temperature fluctuations were attenuated, on average, by about 85-90% with 0.5 m intake tube, and by about 90-95% with 1 m intake tube, minimizing sensible heat flux portion of Webb-Pearman-Leuning term. The remainder was measured directly eliminating open-path heating or any other temperature issues. Fast temperature and pressure measured inside the cell of LI-7200, and low sensitivity to window contamination allowed for the use of short intake tube (0.5-1.0 m or less) with or without intake filter, and leading to a low power demand for the pump and entire system. The power demand of the tested blower with flow control was about 15 W, which is considerably less than that of traditional closed-path systems (about 50-100 W), and could be reduced further, to about 7-10 Watts, by selecting different fan without flow control.

Frequency losses for CO_2 and H_2O fluxes from LI-7200 were small, yet slightly higher than that by LI-7500 (on average, 12% vs. 8% for 0.5 intake, 13% vs. 9% for 1 m intake) as expected due to some high frequency attenuation by a short intake tube. For comparison, frequency losses for closed-path LI-7000 with 4.5m intake tube were between 15 and 30%. Hourly CO_2 and H_2O fluxes were within 2% of the standards (LI-7000 and LI-7500, respectively) after all appropriate corrections are applied. The observed 2% difference was not statistically significant for P-value<0.05. Flux data loss over duration of all experiments was at about 7% for open-path LI-7500 mostly due to precipitation (74% loss during precipitation events). For the same period, losses from closed-path LI-7000 were less than one percent. Data loss of LI-7200 was close to that of LI-7000, but with power and maintenance requirements close to those of LI-7500, and substantially below those of LI-7000.

New LI-7200 gas analyzer utilized strengths of both open-path and closed-path designs. Similar to the closed-path LI-7000 analyzer, it has minimal data loss during precipitation events and icing, and it does not have surface heating issues. Similar to the open-path LI-7500, the new LI-7200 has good frequency response (close to that of LI-7500) due to small and easily correctable flux attenuation loss in short intake tube, it does not need frequent calibration, has minimal maintenance requirements, and can be used in very low power configuration with short intake tube. It is also small, light-weight and weather-proof.

P208

OPEN-PATH EDDY COVARIANCE MEASUREMENTS OF METHANE FLUX

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Poster II

Methane is an important greenhouse gas with a warming potential of about 23 times that of carbon dioxide over a 100-year cycle. Measurements of methane fluxes from the terrestrial biosphere have mostly been made using flux chambers, which have many of advantages, but are discrete in time and space and may disturb surface integrity and air pressure. Open-path analyzers offer a number of advantages for measuring methane fluxes, including undisturbed *in-situ* flux measurements, spatial integration using the Eddy Covariance approach, zero frequency response errors due to tube attenuation, confident water and thermal density terms from co-located fast measurements of water and sonic temperature, and remote deployment due to lower power demands in the absence of a pump.

The LI-7700 open-path methane analyzer is a VCSEL (vertical-cavity surface-emitting laser)-based instrument. It employs an open Herriott cell and measures levels of methane with RMS noise below 5 ppb at 10 Hz sampling in controlled laboratory conditions. The power consumption of the stand-alone LI-7700 in steady-state is about 8W, so it can be deployed in any methane-generating location of interest on a portable or mobile solar-powered tower, and it does not have to have grid power or permanent industrial generator.

Eddy Covariance measurements of methane flux using the LI-7700 open-path methane analyzer were conducted in 2006-2009 in five ecosystems with contrasting weather and moisture conditions: (1) sawgrass wetland in the Florida Everglades; (2) coastal wetlands in an Arctic tundra; and (3) pacific mangroves in Mexico; (4) maize field and (5) ryegrass field in Nebraska. Eddy covariance flux data from a co-located LI-7700, LI-7500, and sonic anemometer were collected at 10-20 Hz. Data were processed using EdiRe software following standard FluxNet methodology, with stationarity tests, frequency response, and density corrections.

Methane co-spectra behaved in a manner similar to that of the co-spectra of carbon dioxide, water vapor, and air temperature, demonstrating that the LI-7700 adequately measured fluctuations in methane concentration across the whole spectrum of frequencies contributing to vertical atmospheric turbulent transport at the experimental sites. The surface heating effects were not observed in the path even when over 1000 Wm^{-2} of artificial heat was provided to the path via mirror heaters. All co-spectra also closely followed the Kaimal model, and demonstrated good agreement with another methane co-spectrum obtained with a TDLS (Tunable Diode Laser Spectroscope; Unisearch Associates, Inc.) over a peatland. Overall, hourly methane fluxes ranged from near-zero at night to about 4 mg m^{-2} h^{-1} in midday in arctic tundra. Observed fluxes were within the ranges reported in the literature for a number of wetlands in North America, including the Everglades wetlands. Diurnal patterns were similar to those measured by closed-path sensors.

The LI-7700 open-path analyzer is a valuable tool for measuring long-term eddy fluxes of methane due to the good frequency response and undisturbed *in-situ* sampling. It enables long-term deployment of permanent, portable or mobile CH4 flux stations at remote locations with high CH4 production, because it can be powered by a solar panels or a small generator.

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CARBON BUDGET OF TEMPERATE GRASSLAND IN CHINA AND ITS TREND IN THE FUTURE

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Based on the data of eddy covariance observation and biomass/net primary productivity (NPP) from intensive site studies and the field measurements of temperate grassland region in China, Terrestrial Ecosystem Model (TEM, Version 5.0) was parameterized and verified; the carbon budget and spatial-temporal variation of the temperate grassland in China during 1951-2007 as well as their responses to increasing atmospheric CO_2 and climate variability were simulated. The results indicated that the temperate grassland in China acted as a slight carbon sink with the yearly average value of 0.233gCm^{-2}, ranging from -5.8±1.28 to 5.26± 0.7gCm^{-2} in the total study area of 64.96 million ha during 1951-2007. The contributions of typical steppe, forest and desert steppe to the whole carbon budget were about 66%, 27% and 7%, covered about 44%, 37% and 19% of the total area, respectively. Sensitivity experiments indicated that different types of temperate grassland had different sensitivities to atmospheric CO_2 concentration and climate change: mean annual carbon budget of temperate grassland was about 2.41TgC when atmospheric CO_2 concentration alone was considered, ranging from -7.59~9.73TgC; about 0.043TgC when temperature variability alone was considered, ranging from -32.1~25.9TgC; about 1.09TgC when precipitation variability alone was considered, ranging from -90~67TgC which was 3~4 times greater than comparable fluctuations caused by temperature variability; about 0.1TgC when both temperature and precipitation variability were considered, ranging from -99.5~78.9TgC; and about 0.278TgC when both atmospheric CO_2 concentration and climate variability were considered, ranging from -6.9~6.27TgC. It indicated that temperate grassland in China would become an increasing carbon sink if current pattern of climate change continued in the future. Temperature variability and increasing atmospheric CO_2 concentration had the greatest impact on typical steppe while precipitation variability had the greatest impact on desert steppe, implying that typical steppe has the largest contribution to the carbon sequestration potential of the temperate grassland in China if current climate pattern happens in the future in this region.

P210

SEASONAL CHANGES IN NET ECOSYSTEM EXCHANGE OF CO_2 AND RESPIRATION OF *CENCHRUS CILIARIS* L. GRASSLAND ECOSYSTEM IN SEMI-ARID TROPICS: AN EDDY COVARIANCE MEASUREMENT

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Abstract

The daily net ecosystem CO_2 exchange, diurnal pattern of net CO_2 exchange and ecosystem respiration of *Cenchrus ciliaris* grassland in semi-arid region were studied during July, 2008- June, 2009 using eddy covariance measurement. The active season during which daily net CO_2 uptake was observed corresponded with the wet season which lasted for 7 months. High CO_2 uptake was observed during September to December. Pulses in CO_2 release occurred with the rewetting of the soil by summer rain events during dry period. The amplitude of daytime and nocturnal ecosystem CO_2 exchange increase by many folds during the active season when compared with the dry season. Ecosystem respiration exhibit strong positive relationship with soil moisture (r^2=0.768) but negatively correlated with soil temperature (r^2=0.498). The seasonal changes in net ecosystem exchange and ecosystem respiration were strongly regulated by soil moisture, therefore, the phase of the net uptake and release of CO_2 by the ecosystem depend on the balance between the wet season and the dry season.

P211

CARBON DIOXIDE RESPIRATION CHARACTERISTICS WITH PHYSICOCHEMICAL PROPERTIES OF SOILS AT THE COASTAL ECOSYSTEM IN SUNCHEON BAY

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This paper was studied CO_2 respiration rate with physicochemical properties of soils at wetland, paddy field and forest in Nongju-ri, Haeryong-myeon, Suncheon city, Jeollanam-do. Soil temperature and CO_2 respiration rate were measured at the field, and soil pH, moisture and soil organic carbon were analyzed in laboratory. Field monitoring was conducted at 6 points (W3, W7, W13, W23, W27) for wetland, 3 points (P1, P2, P3) for paddy field and 3 points (F1, F2, F3) for forest in 10 January 2009. CO_2 concentrations in chamber were measured 352~382 ppm for wetland, 364~382 ppm for paddy field and 379~390 ppm for forest, and the average values were 370 ppm, 370 ppm and 385 ppm, respectively. CO_2 respiration rates of soils were measured -73~44 mg/m^2/hr for wetland, -74~24 mg/m^2/hr for paddy field and -55~106 mg/m^2/hr for forest, and the average values were -8 mg/m^2/hr, -25 mg/m^2/hr and 38 mg/m^2/hr. CO_2 was uptake from air to soil in wetland and paddy field, but it was emission from soil to air in forest. CO_2 respiration rate function in uptake condition increased exponential and linear as soil temperature and soil organic carbon. But, it in emission condition decreased linear as soil temperature and soil organic carbon. CO_2 respiration rate function at wetland moisture decreased linear as soil moisture, but it at paddy and forest increased linear. CO_2 respiration rate function at all sites increased linear, and increase rate in forest was highest.

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SPATIAL AND TEMPORAL PATTERNS OF SOIL RESPIRATION OVER THE JAPANESE ARCHIPELAGO: A MODEL-INTERCOMPARISON STUDY

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Soil respiration, i.e., CO_2 efflux from the soil surface incorporating plant root and microbial respirations, is one of the largest fluxes in ecosystem carbon cycle. Globally, it accounts for approximately 70–80% of ecosystem respiration, which has a potentially strong positive feedback effect on human-induced climate change. Previous observational and modeling studies suggest that soil respiration occurs heterogeneously over land surfaces, due to differences in topography, geology, vegetation cover, and microenvironment. It is still difficult to evaluate soil respiration at landscape and higher scales, leading to an uncertainty regional carbon budget accounting.

In this study, soil respiration of terrestrial ecosystems over the Japanese Archipelago was evaluated using five terrestrial models: VISIT, LPJ, CASA, Biome-BGC, and SEIB. These models estimate soil respiration with a common concept of carbon cycle but using different parameterizations for temperature and soil moisture responsiveness. In VISIT, root respiration rate is estimated for floor and tree roots, respectively, comprised of maintenance and growth respirations. Heterotrophic microbial respiration is estimated as a function of soil temperature and moisture content, for each of litter and humus carbon pools. These models were applied to the Japan region (30°-50°N, 125°-150°E, except unban and agricultural areas) at a spatial resolution of 2min x 2min for latitude and longitude, during the period from 1990–2006 at daily time-step.

In the case of VISIT, total soil respiration of the Japanese Archipelago was estimated as 392 ± 14 Tg C yr^{-1} (mean ± S.D. of interannual variability); areal average rate is 10.7 Mg C ha^{-1} yr^{-1}. Root respiration accounts for, on average, 48.3% of the total soil respiration. Higher rates occurred in warmer years: e.g., 413 and 410 Tg C yr^{-1} in 2004 and 1998, respectively. Spatial distribution (Fig. 1) shows that warm and humid southwestern parts have higher soil respiration rate, as inferred from the distribution of primary productivity.

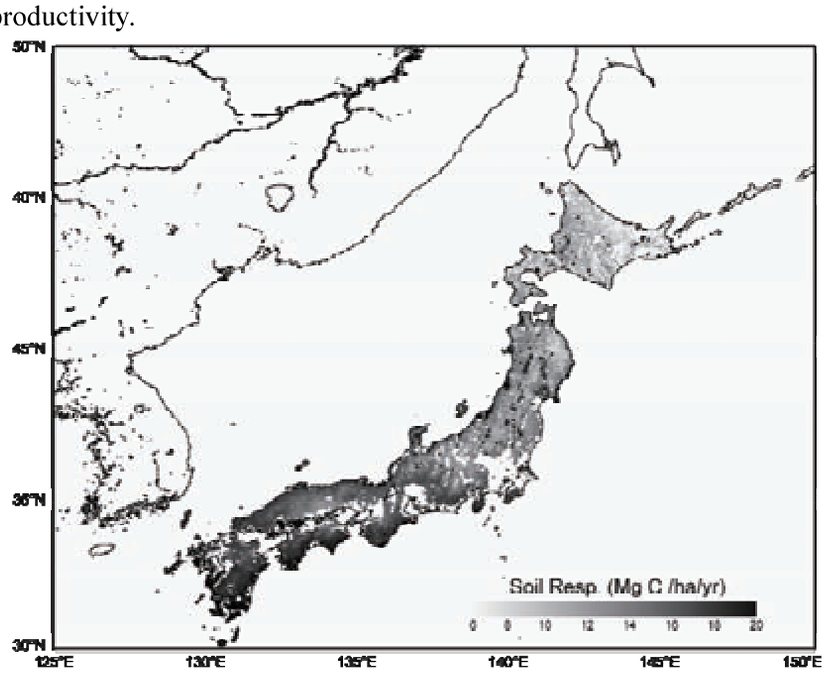

Fig. 1 Distribution of soil respiration in 2006 estimated by VISIT

We are analyzing inter-model variability in terms of spatial distribution, root/microbial fractions, and seasonal/ interannual variability, to discuss the uncertainty in model evaluation. Finally, we will present a model-composite map of soil respiration, which may have higher credibility (i.e., less model-specific biases), over the Japanese Archipelago.

P213
CHANGES IN CARBON DIOXIDE SEASONS IN THE WARMER CLIMATE

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Monitoring of inter-annual or intra-annual changes in global atmospheric chemistry is an important task necessary for improved projections of climate change due to increases of greenhouse gases. Such change will likely redistribute water, energy, and chemical components in the Earth's climate system. Seasonal cycles as well as the magnitude of carbon uptake by terrestrial vegetation are good indicators and may globally help to understand the feedbacks between the atmosphere and biosphere under the changing atmospheric chemistry. In this study, carbon dioxide (CO_2) seasons, which represent a high CO_2 concentration period in non-growing seasons, are objectively defined based on numerous *in situ* observations over recent decades. Long-term changes and associations with other climate cycles are examined. Analyses of time series of their onset, offset, and duration demonstrate that carbon dioxide seasons have shortened at most locations across the Northern Hemisphere, primarily due to earlier offsets. Results suggest the occurrence of a series of feedbacks between the atmosphere and biosphere as the climate warms, in which anthropogenic CO_2 increases in non-growing seasons, warmer winters and springs occur due to intensifying greenhouse effects, and the uptake of carbon dioxide by vegetation begins earlier in the growing seasons due to the earlier onset of spring phenology, mitigating late spring warming. These feedbacks also suggest that vegetation is an important mitigating factor for global warming against the increasing anthropogenic CO_2 at seasonal scales.

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P214

MODELING SLASH PINE PLANTATION NPP BASED ON STEM-ANALYSIS DATA AND ALLOMETRIC EQUATIONS

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Net Primary Productivity (NPP) is one of the most important components of carbon exchange in terrestrial ecosystem. A large proportion of carbon in vegetation is stored in tropical and subtropical forests. Slash pine is an important introduced tree species and is widely cultivated in subtropical of China since 1980s. In Qianyanzhou Experimental Station(115º04'13"E, 26º44'48"N), slash pine was cultivated at 1984. After 20 years restoration, we wanted to make it clear that what's the magnitude of aboveground biomass and what's the magnitude in each year. In this study, aboveground biomass of slash pine is divided into two parts, i.e. branch biomass (including leaf biomass) and trunk biomass. Regressive equations of leaf biomass and total biomass of each branch against branch basal diameter (*d*) are established. Basal diameter of all branches on selected trees is measured. Trunk biomass is derived from trunk volume (obtained based on volume table) and trunk density. Average sample tree is cut down and growth rings on discs at different height are measured. Bark thickness for each ring on the disc at breast height is estimated. Then slash pine plantation aboveground net primary productivity (ANPP) is estimated based on plot survey data, allometric equations and the growth rings of the sampled tree.

Our study showed that leaf biomass (*lb*, g) and total biomass (*bb*, g) for each branch are highly correlated to branch basal diameter (*d*, mm), the allometric equations are $lb = 0.0488d^{2.4709}$ (R^2=0.8089, n = 156, P < 0.001) and $bb = 0.0392d^{2.8934}$ (R^2=0.9659, n = 156, P < 0.001), respectively. Foliage biomass (*fb*, g) and aboveground biomass (*ab*, g) are also correlated to diameter at breast height (*D*) for each individual tree, and the allometric equations are $fb = 12.074D^{2.1515}$ (R^2=0.7354, n = 19, P < 0.001) and $ab = 49.58D^{2.4616}$ (R^2=0.9588, n = 19, P < 0.001). Aboveground biomass of slash pine plantation in Qianyanzhou Experimental Station is calculated based on allometric equations and plot survey data, which is 84.98 t ha^{-1}. ANPP of slash pine plantation is increasing gradually since it is planted, but it is strongly influenced by the climatic conditions. In 1998, for example, ANPP is lower than that in 1997 for the heavily drought. The relationship between ANPP and foliage biomass is also discussed in this paper.

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ESTIMATING LARIX FOREST BIOMASS OF 12 PROVINCES IN NORTH CHINA FROM FORESTRY INVENTORY DATA

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Forestry inventory data based biomass was considered as an important method to resolve the problem of large scale forestry biomass calculation. Several models between biomass and volume of *Larix* forest in North China were discussed. The models were base on the data that has been published on journals from 1989. Curve fitting of the relationship between biomass and volume was chosen from linear, polynomial, power and hyperbolic. The results showed that different curve fitting wasn't the main factor to the result but the forest location, age and origin, if there were enough sites data. The relationship between biomass and volume could be expressed as polynomial and hyperbolic curve better than linear or power curve. Polynomial and hyperbolic curve can resolve the problem of different region and age that linear curve can't. Power curve can't be used widely. Compared all the results, we regarded 4.397×10^8t as a better result for the biomass of *Larix* when the sixth Inventory data was measured.

P216

STEM RESPIRATION IN A SUBTROPICAL MONTANE CLOUD FOREST

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The characteristics of stem respiration and its contribution to ecosystem respiration were studied in a subtropical montane cloud forest from June 2008 to July 2009. The Chi-Lan Mountain (CLM) site (24°35'N, 121°25'E) is located in northeastern Taiwan at an altitude of 1400 to 1800 m a.s.l. Due to a high annul precipitation rate and the predominant foggy condition, the *Chamaecyparis obtusa* var. *formosana* forest is subjected to moist environment both in the soil and in the air. One of the effects of the high humidity is a very low soil respiration rate measured at this site.

To study the CO_2 efflux from the woody tissue of the *C. obtusa* var. *formosana* trees, the LI-COR soil respiration system with the 8100-102 Survey Chamber was employed to the stem of the trees. The spatial variation of stem respiration was studied at 1.0 m height above ground of 25 trees. Three trees of them were selected for the measurement at four heights (1.0, 2.0, 4.0, and 6.0 m). The measurement at these points was conducted about once per month and lasted for one year. To study the temporal variation of stem respiration and the controlling factor of it, the Survey Chamber was mounted on one of the trees at 1.0 m height. The respiration rate was measured every 10 minutes for one year. The temperature of the stem of 3 cm depth from beneath the bark was monitored at the four heights of two trees and also beside the point where the stem respiration was continuously measured.

The results showed that the value of stem respiration varied from 0 to 2.5 μmol C m^{-2} s^{-1} throughout the year, about the same magnitude of soil respiration of the site. A preliminary evaluation of stand-scale stem respiration rate using the stem surface area index of 0.49 m^2 m^{-2} showed a lower rate than the soil respiration. However, if the 1.2 m^2 m^{-2} of branch surface area were taken into account, the contribution of aboveground woody tissue to the ecosystem respiration might be of the same magnitude as the soil respiration.

The stem respiration rate at 1.0 m height was independent on the diameter of the trees, while the respiration rate increased with increasing height of the stem. Since the continuous measurement of stem respiration showed a highly dependence of the rate on the stem temperature, the higher respiration rate at higher stem region might result from the temperature gradient of the stem.

[ǂ] In memorial of Mr. Hao-Kuei Wang (1984-2009)

P217

EVALUATIONS OF NIGHTTIME ECOSYSTEM RESPIRATION OVER A CHINESE PADDY FIELD USING TIME SERIES OF CO_2 DENSITIES AS WELL AS EDDY CORRELATION METHOD

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The ecosystem respiration is an important component of terrestrial carbon budget. Its accurate evaluation is very important for calculating seasonal or annual terrestrial carbon budget. The study was conducted for evaluating nighttime ecosystem respiration at atmospheric stable condition. Observations were carried out over a paddy field located in Shouxian, China at 32.55°N, 116.78°E, 22.7 m A.S.L. using eddy covariance technique with 32.2m height tower. Atmospheric CO_2 density was measured at three different heights (3, 12 and 32 m) from surface using infrared gas analyzer (LI-7500, Li-Cor. USA). We introduced an alternate approach to evaluate ecosystem respiration using eddy covariance fluxes (*Fc*) for windy night and storage changes (*Sc*) for calm night. Selection criteria for windy and calm condition in a night was based on friction velocity (u_*). At calm night conditions *Sc* can be used as emission rate. A good agreement was found between calm night *Sc* and windy night *Fc* when *Sc* was calculated on 30 minutes scale. We evaluate calculation of *Sc* either 6 hrs (18:00-23:00) and 12 hrs (18:00-6:00) time scale and found a good relation of *Sc* in almost similar range and seasonality with *Fc*. Some scattered of *Sc* related to high CO_2 density fluctuation at highly atmospheric stable and very low u_* (u_*<0.05) condition.

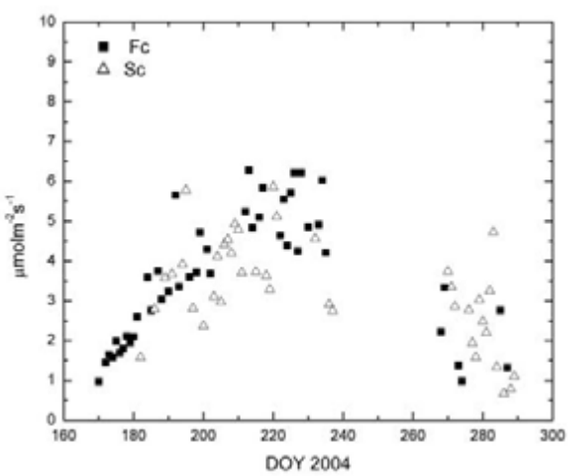

Fig. Seasonal change of eddy covariance flux (*Fc*) and storage change (*Sc*) over a paddy field in China.

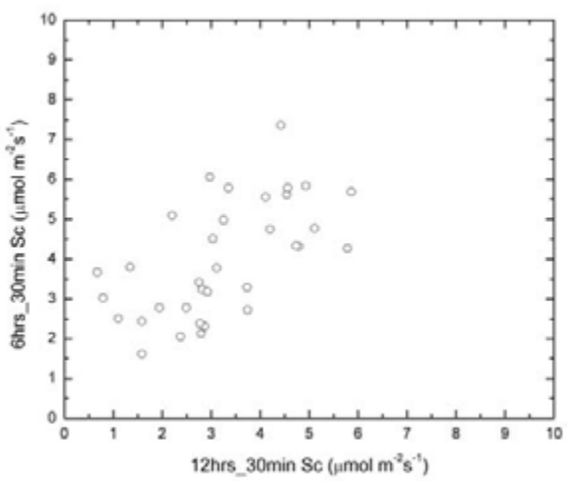

Fig. Comparison between *Sc* calculated from 6 hrs and 12 hrs time scale.

Key words: Eddy covariance, ecosystem respiration, storage change, paddy

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ESTIMATING THE SCALAR TRANSFERS WITHIN AND ABOVE A DEEP FOREST CANOPY BY USING A MULTILAYER FORWARD CLOSURE MODEL IN CHI-LAN MOUNTAIN STUDY SITE IN TAIWAN

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Quantifying the exchange of scalars (e.g., carbon dioxide, water vapor, temperature, or other chemical species) within the canopy between the leaves or other components (stems, roots, and branches) and their immediate microenvironment is made difficult by a 2-way interaction in which the microenvironment exerts controls over scalar exchange at the leaf surface, and leaves have some capacity to regulate their own microenvironment through stomatal opening and closure. This 2-way interaction is complicated by the canopy structure, i.e. vertical distribution of foliage within the canopy, leading to significant vertical gradients in the radiation environment and airflow regimes. The intrinsic non-linearity in leaf physiological responses (e.g. leaf-level photosynthesis and transpiration) to radiation further exasperates this difficulty. In order to estimate such transfer, several multi-layer one-dimensional models have been developed to resolve the two-way interaction between leaf and microclimate using turbulent transport theories in conjunction with detailed physiological and radiative transfer principles. However, the analysis is even more difficult when the ecosystem is in the mountain with complicate meteorological conditions.

In this study, we are trying to employ a multilayer canopy-vegetation model to quantify the scalar transfer within the canopy volume and estimate the canopy-top scalar fluxes by utilizing the long-term measurements of scalar quantities, meteorological variables, and eco-physiological parameters collected in Chi-lan Mountain study site in the northeast of Taiwan in the past few years. In the analysis, a numerically forward method with higher-order closure scheme is developed for the simulations. In addition, detailed parameterizations of the eco-physiological responses are conducted in the analysis. The modeled results will then be compared with the tower flux measurements in different temporal scales to better quantify the biosphere-atmosphere interaction in this study site.

P219

ETP – A NETWORK OF FLUX STUDY SITES IN TREE-BASED CROPPING ECOSYSTEMS IN TROPICAL ASIA, OCEANIA, AMERICA AND AFRICA

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The research unit "Functioning and Management of Tree-Based cropping Ecosystems" of the French Agricultural Research Centre for International Development (CIRAD) has developed, together with national and international partners, a network of sites devoted to the study of carbon, water and nutrients cycles in tropical tree-based cropping systems.

We focused on major tree-crops located in tropical Asia, Oceania, Central and South America, and Africa. The different ecosystems - eucalyptus in Congo and Brazil, rubber tree in Thailand, coffee-based agroforestry systems in Costa Rica and India and coconut tree in Vanuatu - provide complementary features in terms of functioning, output, management, ecological conditions, risk o nutrient deficiency, and water stress. For example, in intensively-managed Eucalyptus plantations in Brazil, the partitioning of NPP occurs to the benefit of stem wood production, which is the commercial product in these plantations, but to the detriment of litter, which, in fine is likely to affect soil organic matter (SOM) dynamics. On the opposite, in productive coconut plantations of Oceania, NPP is lower, but more than 88% of NPP is allocated to organs with high turnover rates of which only a small fraction (copra) is exported. The remaining part of NPP turns into a large litter production which certainly modifies very highly soil biological functioning and SOM dynamics.

As our network combining measurements of fluxes (NEE) and net primary productivity (GPP, NPP), is included in continental (CarboAfrica, Asiaflux) and global networks (FLUXNET) we participate to meta-analyses of water and CO_2 fluxes. Recent papers (Luyssaert et al 2007, Roupsard et al 2008, Beer et al. 2009,…) stressed the importance of our sites, often representing extreme contexts of high NPP, particularly useful for modelling.

Beside measurements of CO_2 and water fluxes by eddy-covariance, we develop an extensive approach to assess the functioning of these ecosystems, as shown in figure 1.

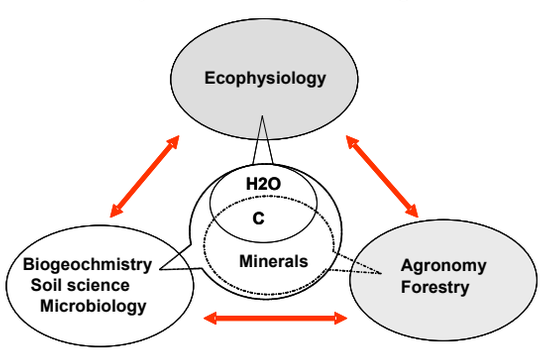

Figure 1. Framework of the approach developed to study the functioning of tree-crop based ecosystems

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P220

FOLIAR NITROGEN AND CARBON STOICHIOMETRY OF THREE CONIFEROUS SPECIES IN NORTH CHINA

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For most of the terrestrial ecosystems are nitrogen dificient, N content and C: N ratio are considered as main factors for ecosystem physiological processes while foliar $d^{13}C$ values are indicative of long-term integrated photosynthetic and water use characteristics according to previous researches. Here we studied the differences of foliar nitrogen and carbon stoichiometrhy for three dominant coniferous species *Pinus sylvestris var. Mongolica*, *Pinus tabulaeformis* and *Larix gmelini* in north China, and the spatial variations for the former two species which were widely used in platation construction in "Three North" area. Plant and soil samples were collected at 12 sites through a northeast to sourthwest transect in 2007. Mature sun-exposed leaves were collected, 3 to 5 replicates for each species at each site and at the same time soil samples consists of six different layers each(0-2cm, 2-5cm, 5-10cm, 10-20cm, 20-30cm, 30-40cm) were collected too. All these samples are measured by Finnigan MAT251 mass spectrometer.

The main results are as follow: *P. sylvestris var. Mongolica*, *P. tabulaeformis* had lower foliar nitrogen concentrations and higher WUE compare to *L. gmelini*r. The WUE corralated with foliar N content possitively for *Pinus*(Sig.< 0.01). *P.sylvestris var. Mongolica* used water more efficiently than co-occuring *P. tabulaeformis* as to higher foliar nitrogen content.

Poster II

P221

MEASUREMENTS OF TURBULENCE, HEAT FLUXES AND GREENHOUSE GAS FLUXES ABOVE TROPICAL RAIN FOREST AND OIL PALM IN SABAH, MALAYSIAN BORNEO

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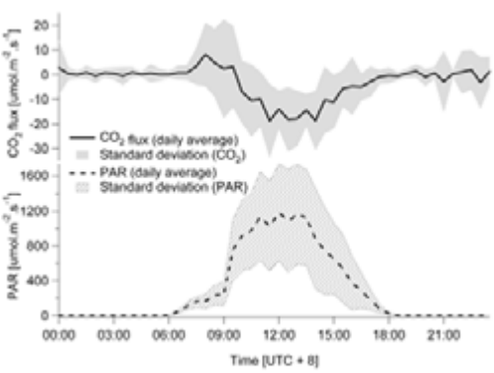
Three intensive field campaigns were held in Malaysian Borneo during the first half of 2008 by a NERC-funded consortium of 8 UK institutions aiming at investigating Oxidant and Particle Photochemical Processes (OP3). Fluxes of heat and CO_2 were measured during two periods (April and June/July 2008) at the Bukit Atur Global Atmospheric Watch (GAW) tower located in the Danum Valley conservation area, Sabah; this tower stands 100 m tall and is situated on a hill leading to an effective measurement height of 200 m above the rainforest canopy. The forest directly surrounding the GAW tower can be described as a selective logged diptocarp forest, with primary forest in the Danum Valley Conservation Area 10 km S of the tower. Fluxes of carbon dioxide, latent and sensible heat were measured by eddy-covariance at a height of 75 m atop the GAW tower. Similar measurements were taken at the Sabahmas oil palm plantation, located 70 km NE east of the GAW site, during an intermediary campaign in May 2008, from a 15 m tower over the 12 m plantation. In addition to the measurements of day-time CO_2 exchange, soil emissions of methane (CH_4) and nitrous oxide (N_2O) were measured in different forest plots and at the plantation using a manual static chamber technique.

Because the experimental setup was not suited to quantifying night-time respiration at the very low wind speeds encountered, the analysis of the CO_2 fluxes focuses on the daytime fluxes. At the GAW site, daytime CO_2 fluxes (F_c) were found to be highly correlated to photosynthetic activity whilst night time fluxes did not exhibit any dependence on air temperature confirming that dark respiration could not be observed, except for a peak of upward fluxes in the early morning (ca. 8:00 – 9:00 am) which were attributed to the growth of the mixing layer after sun rise (Figure 1).



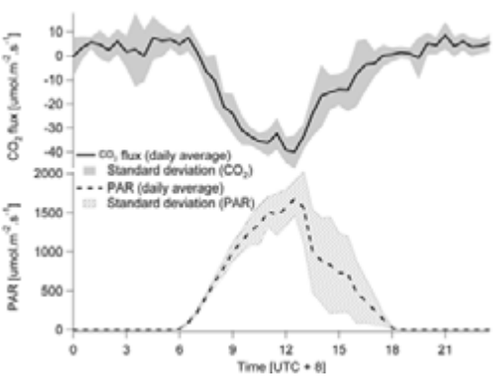


Figure 1: Diurnal profiles of CO_2 fluxes (F_c) and photosynthetically active radiation (PAR) at (left) Bukit Atur forest site (23/06 – 17/07/2008) and (right) Sabahmas oil palm.

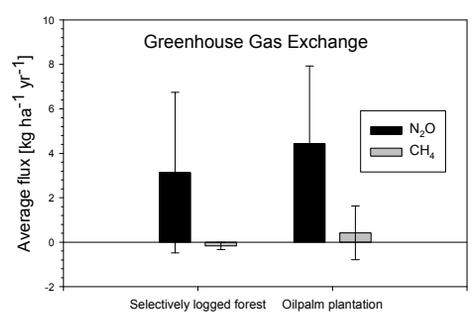


Figure 2: CH_4 and N_2O exchange at forest site and oil palm plantation.

CO_2 concentrations ranged from 355 to 395 ppmv; the highest values were observed in the morning and coincided with surges in F_c caused by the flushing out of the nocturnal boundary layer, whilst the lowest concentrations were generally recorded during the afternoon, at the height of photosynthetic activity. Day time CO_2 emissions ranged from ca. -10 to - 50 μmol m^{-2} s^{-1}; maximum emission rates were comparable to peak day time fluxes recorded at the Sabahmas plantation. The forest site was found to be a sink of CH_4 (ca. 0.2 kg.ha^{-1}.yr^{-1}), and the plantation a net source (0.4 kg.ha^{-1}.yr^{-1}). Both forest and plantation were however net sources of nitrous oxide (3.2 and 4.4 kg.ha^{-1}.yr^{-1}, respectively).

P222

A DECADAL STUDY ON CARBON BUDGET IN RICE PADDY FIELDS

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Poster II

Agricultural land use in monsoon Asia is characterized by rice paddy fields. According to statistics of FAO, harvested area of paddy rice is 1.52 million km^2, 89% of which is located in East, Southeast and South Asia on average from 2002 to 2007. Continuous cropping of paddy rice enables more than 3 billion people to live in those areas. The most distinctive feature of rice paddy fields is flooding in the cultivation period. Flooding influences carbon exchange in rice paddy fields: it works as barriers in gas diffusion between soil and the atmosphere, reduces decomposition of soil organic matters, and produces methane in soil under anaerobic conditions. Rice paddy fields are mostly drained in the fallow period, in which decomposition of soil organic matters progresses gradually. Carbon budget in rice paddy fields is also influenced by agricultural practices like manure application, harvest and subsequent disposal of crop residue. Although rice paddy fields are distributed widely in monsoon Asia, cropping pattern is not the same. In tropical and subtropical areas with sufficient water supplies, multiple (double or triple) cropping of rice is common, while in mid-latitudes with humid summer and dry winter, double cropping of rice and wheat (or barley) or single cropping of rice is practiced. Carbon budget in rice paddy fields is influenced by the cropping patterns and related cultivation practices. To investigate and quantify carbon budget in rice paddy fields, we have been continuing observation at Mase site, a customarily cultivated single-rice cropping field in central Japan, since 1999. We added two more sites, a double-rice cropping field at Mymensingh, northern Bangladesh, from 2006, and a rice-wheat cropping field at Jiangdu, Jiangsu Province, China, from 2007. In this paper, we summarize results of our study in those sites until now.

Carbon exchange at the single-rice cropping paddy field (Mase site) consists of a short (<5 months) active growing season and the remaining dormant fallow season. In the growing season, the amount of carbon equivalent of about a half of GPP was released to the atmosphere through RE. Both GPP and RE in the growing season showed inter-seasonal variabilities exceeding 1.5 Mg C ha^{-1} $season^{-1}$. Inter-seasonal variabilities in the total GPP were attributed to differences in the amount of APAR, which was influenced by the amount of incident PAR and the fraction of diffuse PAR. RE in the growing season under drained conditions was parameterized by using the specific respiration rate on canopy scale (RE per above-ground biomass excluding panicles). Inter-seasonal variabilities in the total RE in the growing season were attributed to differences in effective accumulated temperature. Soil CO_2 flux measured by flux chambers indicated that about 30% of RE in the growing season came from decomposition of soil organic matters. This estimate is supported by stable carbon isotope studies. After harvest, crop residue (rice straw, stubble and roots) was plowed into soil, which activated microbial decomposition of organic matters and resulted in large CO_2 efflux for several weeks. In the following period, weak CO_2 efflux (<1 g C m^{-2} d^{-1}) continued until the beginning of the next growing season. On annual basis, the amount of carbon equivalent of about a half of the growing season NEP was taken away from the field at harvest, and the remaining half was released to the atmosphere through decomposition in the fallow season. The preset estimate of the annual carbon budget at Mase site including minor components such as methane and dissolved carbon was -0.4 ± 0.5 Mg C ha^{-1} y^{-1} on average from 2002 to 2007, indicating that the field is almost carbon-balanced. This estimate is similar to previous estimates by the biometric method, and also consistent with long-term trend in soil carbon which has been monitored at various experimental paddy fields in Japan.

Main components of carbon budget in multiple cropping paddy fields are the same as those at Mase site. In quantity, however, the annual NEP observed at the multiple cropping sites was triple or more the amount at Mase site. The larger annual NEP at the multiple cropping sites was principally caused by longer growing season, and additionally caused by inundated field conditions at Mymensingh site in the monsoon intercropping period. Another important factor influencing carbon budget at the multiple cropping sites is management of crop residue. At Mymensingh site, rice straw was mostly taken away from the field, whereas at Jiangdu site, rice and wheat straw were burnt in the field. For estimates of carbon budget in rice paddy fields on larger scales, one of the large uncertainties is management of crop residue, which is affected by various factors such as demands for straw, methods of harvest and regulation of air pollution.

P223

EXPERIMENTAL VALIDATION OF WPL CORRECTION FOR CO_2 FLUX BY EDDY COVARIANCE TECHNIQUE OVER ASPHALT SURFACE

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The WPL correction is indispensable when evaluating trace gas flux by the eddy covariance technique using the open-path gas analyzer. The theoretical discussion of this WPL correction to date has not been contradicted, however, the experimental validation of WPL correction has been hardly performed. This study experimentally validated the accuracy of WPL correction by simultaneously measuring CO_2 fluxes by the closed-path eddy covariance (CP) and closed-chamber (CC) techniques in addition to the open-path eddy covariance technique (OP) over the asphalt surface assuming that the net CO_2 flux is almost zero.

The raw CO_2 flux by OP was always negative (apparently downward from the atmosphere to the asphalt surface) between –0.054 and –0.494 mg m^{-2} s^{-1} (the average was –0.320 mg m^{-2} s^{-1}). The WPL CO_2 correction term for sensible heat flux (WPL(SHF)) was always positive between 0.056 and 0.491 mg m^{-2} s^{-1} (SHF was between 28 and 249 W m^{-2}), and showed a diurnal variation as opposed to the raw CO_2 flux. The WPL correction term for latent heat flux (WPL(LHF)) was between –0.008 and 0.024 mg m^{-2} s^{-1} (raw LHF was between –21 and 65 W m^{-2}), and did not have an influence over the WPL correction on the CO_2 flux. Finally, net CO_2 flux by OP was almost positive between –0.026 and 0.122 mg m^{-2} s^{-1} (the average was 0.019 mg m^{-2} s^{-1}), which is the same result as Kondo and Tsukamoto (2008). There was no significant difference by the SAT's instrumental error (with Kaijo, Gill, and Young) of net CO_2 flux by OP.

Net CO_2 flux by CP was almost zero between –0.017 and 0.044 mg m^{-2} s^{-1} (the average was 0.437 × 10^{-3} mg m^{-2} s^{-1}), and did not show the systematic variation like the net CO_2 flux by OP. Net CO_2 flux by CC was always positive between 0.059 and 0.320 × 10^{-3} mg m^{-2} s^{-1} (the average was 0.186 ×10^{-3} mg m^{-2} s^{-1}), and was close to the net CO_2 flux by CP. Our results suggest that the original WPL correction should cause an overestimated correction to the CO_2 flux by the open-path eddy covariance technique.

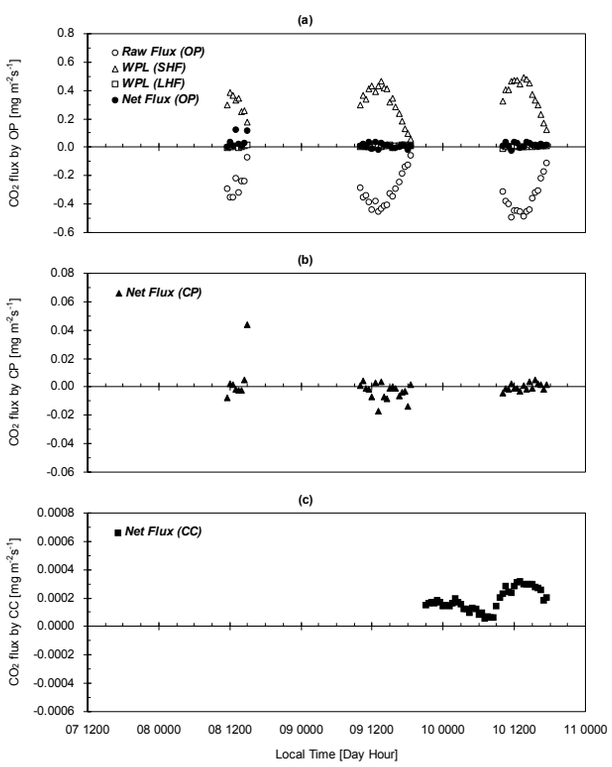

Fig. 1. Time-series data of net CO_2 fluxes by OP (a), CP (b), and CC (c) over the asphalt surface.

P224

OBSRVATION AND MODELING OF THE SENSITIVITY OF CARBON SEQUESTRATION TO HARVESTING AND CLIMATE IN A TEMPERATE CYPRESS FOREST

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Poster II

Temperate forest is though to be a significant carbon sink, because the forest is now recovering from deforestation. Long-term observations of carbon fluxes have revealed the important processes to control the carbon cycle. According to previous studies, we have much of evidence that the carbon balance in temperate forests was highly sensitive to the interannual weather anomalies, such as light, temperature, and water conditions. However, it is still uncertain how the carbon sequestration is controlled by the stand disturbance, management, projected climate change, and increase of atmospheric CO_2 concentration. A cypress is a major plantation species in Japan, and the response to the environmental factors should impact the regional carbon balance. In this study, we evaluate the current status of a planted Japanese cypress forest, and examine the important controlling factors that affect the carbon sequestration, including stand disturbance, climate variables, atmospheric CO_2 concentration, and management, by using continuously observed flux data, tree ring analyses, and a terrestrial biosphere model.

Observation has been conducted at a Japanese cypress forest in the Kiryu Experimental Watershed (KEW), central Japan (34°58' N, 136°00' E). The forest was planted at late 19th to early 20th, and used be a mixed forest of *Chamaecyparis obtusa*, *Pinus thunbergii*, and *Pinus densiflora*. From 1959 to 1977, this forest was intermittently harvested, and then planted *Chamaecyparis obtusa*. Continuous observation of carbon and water fluxes has been conducted by the eddy covariance and relaxed eddy accumulation methods since 2001. Tree-ring width was measured for 25 individual trees. A terrestrial biosphere model, BIOME-BGC, was used to understand the carbon cycle after the harvesting and plantation.

The simulated GPP, RE, and NEE were compared with the observed results. The BIOME-BGC model successfully reproduced the observed seasonal variation; greatest carbon uptake owing to the delayed increase of RE form late April to early June, the weaker uptake in other months, and the delayed peak of RE compared with GPP. Annual carbon budget and its interannual variation were also reproduced in the model (Fig. 1). According to the comparison between the observation and the simulation (Fig. 1), the harvesting played an important role to determine the carbon budget. The model simulation considering the harvesting was consistent with the observation, whereas those with steady state condition significantly underestimated the sink. Decadal variations of tree ring width index (TRWI) and the normalized simulated NPP also show the importance of harvesting (Fig. 2). The model simulation with steady state condition was inconsistent with the TRWI, whereas those with harvesting showed the similar decadal variation of TRWI. According to a sensitivity analysis, the examined response of carbon sequestration to harvesting was larger than that to change in weather condition and atmospheric CO_2 concentration. These results indicate that the information for the stand history is

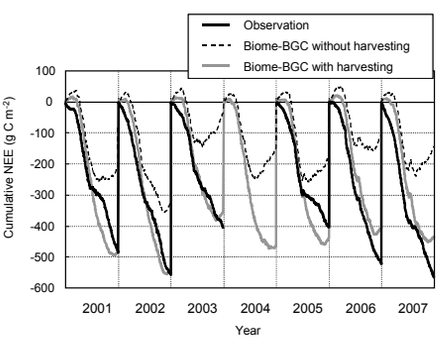

Fig. 1 Cumulative NEE derived from the observation, and simulation with and without harvesting and plantation.

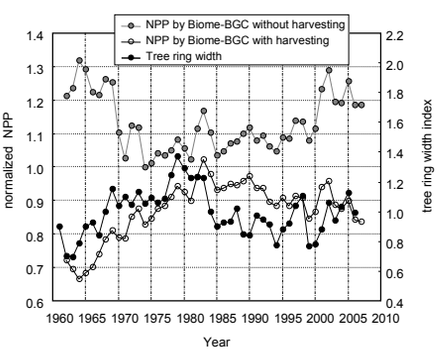

Fig. 2 Interannual variations of tree ring width index and normalized NPP by the simulation with and without harvesting.

P225

EFFECTS OF SNOW AND SOIL-FROST DEPTH ON CO_2 DYNAMICS OVER AND IN AGRICULTURAL SOIL IN HOKKAIDO, NORTHERN JAPAN

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Introduction

Recently, climate change has been affecting the soil-frost penetration depth, frozen period, and timing of snow melt in cold regions. For example, soil-frost depth has decreased due to the increase of the snow layer, which acts as a heat insulator while the air temperature is below freezing point. Agricultural land in cold regions covers approximately 25% of the world total; it is usually managed by human operations and so there is a possibility of controlling greenhouse gas (GHG) emissions. It is therefore important how these environmental changes influence the dynamics of GHGs. In this study, we chose two sites having different climates, and prepared two plots having different snow and soil-frost depth at each site. We compared the CO_2 dynamics over and in agricultural soils among these four plots.

Site and Methods

We used the observation data at two sites in Hokkaido prefecture, northern Japan, from November 2008 to June 2009. One site was Sapporo (141°25'E, 43°05'N) characterized by heavy snowfall and shallow soil-freezing, and the other was Memuro (143°04'E, 42°53'N, about 200 km east from Sapporo) characterized by light snowfall and deep soil-freezing. We prepared two 5 m × 10 m plots (SR, removal of snow cover; CO, untreated control). On the SR plots, snow removal was occasionally conducted by heavy machinery and manual shoveling.

We measured the CO_2 flux from soil, and vertical profiles of gas CO_2 concentration ($[CO_2]$) in soil and temperature from the soil to the air. We used the static chamber method for evaluating CO_2 flux. Gas samples were drawn from the cylindrical chamber (diameter 0.25 m, height 0.40 m) at 1, 11, 21, 31 min after closing the chamber. CO_2 flux was derived as the slope of the linear regression developed $[CO_2]$ in the chamber and time. $[CO_2]$ in soil was measured using the diffusion chamber method. Gas samples were drawn from silicon tubes inserted at the depths of 0.10, 0.20, 0.30 and 0.40 m. These samplings were conducted once every few days. We measured the $[CO_2]$ of these samples by an infrared CO_2 controller or a gas chromatograph equipped with a thermal conductivity detector. Temperatures in soil and snow were measured with copper-constantan thermocouples. We acquired data sets for 40 or 41 days of CO_2 flux and $[CO_2]$. Temperature was recorded by data loggers every 10 min. Soil-frost depth and snow depth were measured about twice a week.

Results and Discussion

Figure 1 shows the meteorological environment and CO_2 dynamics at the Memuro CO plot. $[CO_2]$ in and below the soil-frost layer had increased by the end of March. During this period, there was almost no CO_2 efflux to the air. These results would imply that the soil-frost layer prevented CO_2 in soil diffusing to the air. We could see the large CO_2 emission after soil thawing at the beginning of April. While snow and soil-frost existed, the soil temperature at deeper depth was higher than that at shallower depth, whereas soil temperature at deeper depth was lower than that at shallower depth when there was no snow or soil-frost.

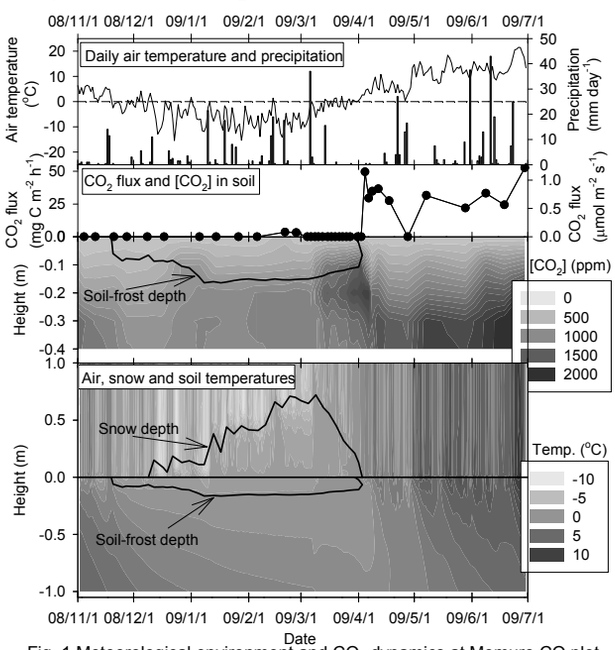

Fig. 1 Meteorological environment and CO_2 dynamics at Memuro CO plot

Poster II

P226

SPATIAL VARIATION OF CO_2 AND CH_4 FLUX IN RIPARIAN ZONE OF WARM-TEMPERATE BROADLEAF FOREST IN JAPAN

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[3] Graduate School, Kyoto University, Kyoto, Japan

The riparian zone is under continuously wet conditions with rich deposition of organic matter. Thus, it is assumed to maintain a high decomposition rate caused by extensive microbial activity under moderate soil water content. On the other hand, the riparian zone has a high water table, and it is assumed that CH_4 is produced by methanogens in the anaerobic zones and oxidized into CO_2 by methanotrophs in the aerobic zones. However, these complex characteristics and factors of spatial variation have not been sufficiently clarified. In the present study, we investigated these variations in the riparian zone.

In the present study, CH_4 and CO_2 soil flux measurement was conducted using the static chamber method in the Yamashiro Experimental Forest (YEF). YEF is located in a valley in Kidugawa City (34°47'N, 135°50'E; 220 m a.s.l.) in Kyoto prefecture, in a mountainous region of western Japan. The annual mean temperature is 15.5°C, and the annual mean precipitation is 1449 mm. The forest consists of more than 50 deciduous broadleaf species (mainly *Quercus serrata*) and evergreen broadleaf species (mainly *Ilex pedunculosa*). The forest canopy is closed and the height averages about 12 m. The 3-year mean annual NEE is estimated to be −1.23 tC ha^{-1} $year^{-1}$.

To measure flux, a cover was placed over the soil collar (20 cm in diameter, 15 cm in height, made from polyvinyl chloride) and 0.5 L of the headspace gas was collected by diaphragm pump into a Tedlar bag (1L) placed inside the closed soil collar. The gas was sampled at 0 and 10 min after the starting time. The interval of periodical flux measurement was once a week. Three plots (riparian, col, and organic matter) were set up at YEF. Eight soil collars were inserted 5 cm deep on aligned slopes in the riparian zone and on a small col near the ridge of YEF to investigate spatial and temporal variation under natural conditions. To investigate the major source of CO_2 and CH_4 in the riparian zone of the forest, 16 soil collars were inserted into a wet area along a small stream. A measured amount of dry organic matter (0, 20 and 40 g, dry weight of leaf, woody tissue and acorn of *Q. serrata* sampled from the forest) was placed in these soil collars. Herbaceous (*Carex alopecuroides var. chlorostachya*) and woody plants (*Eurya japonica Thunb.*) were set in some of the collars to investigate the effect of plant aerenchyma.

To analyze CH_4 concentration, an automated gas chromatograph analyzer equipped with a flame ionization detector (GC-FID; model GC15A, Shimadzu, JP) was used in the laboratory. The packed column of the GC-FID was a Shincarbon ST (Shinwa Chemical Industries, JP). CO_2 concentration was measured using a closed-path CO_2 infrared gas analyzer (IRGA; model LI-840, LI-COR, USA) after CH_4 analysis. Soil temperature, volumetric soil water content and oxidation-reduction potential (ORP) were measured on site using a thermistor (HI 98509, Hnna Instruments, IT), an amplified domain reflectometry device (ADR; model ML-2x, Delta-T, UK) and a platinum-probe ORP meter (ER-1000; Line Precision Instruments, JP) at three locations in the area surrounding each collar. VWC was also confirmed by direct soil water measurement using the oven-drying method at 105ºC for 24 h.

In the riparian zone, peak positive CO_2 and CH_4 soil flux was observed at a position about 1 m away from a stream and on the ridge, respectively. On the col, peak CO_2 emission and soil water content was observed at a position about 20 cm from the bottom of the col. One week later, weak CH_4 emission was observed at the same position even in the upland forest. According to periodical measurement, it is considered that the center of these source areas of CO_2 and CH_4 moved slightly, in response to soil water content, water table level and oxidation-reduction potential in the riparian zone and the col. Clarification of the mechanism would require further intensive continuous measurement.

This work was partially supported by the Global Environment Research Fund (RF-093) of the Ministry of the Environment, Japan.

P227

CO_2 FLUX OBSERVATION IN THE FOOTHILLS OF A HIGH MOUNTAIN

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[2] Hokkaido University, Sapporo, Japan

We have been conducting long-term integrated carbon budget monitoring program at Fuji-Hokuroku (FJH) flux research site in the north foot of Mt. Fuji (3776m) since beginning of 2006. We report the first 3-year measurements (2006-2008) of micrometeorological CO_2 exchange flux over FJH site. The site is located in a Japanese Larch plantation with stand age of about 50 years. Net ecosystem CO_2 exchange (NEE) is measured by eddy covariance (EC) method using both closed path and open path CO_2 gas analyzers. Half−hourly NEE shows violent fluctuation during growing season frequently. Due to the low friction velocity at the site, enhanced contribution from storage term likely contribute to fluctuate upward eddy diffusive transport. The wind system of the site was entirely dominated by northward valley wind in daytime and southward mountain wind in nighttime. During the time when wind direction makes turns soon after the sunrise, we often find dead halt of air-mass around the canopy in the stable vertical temperature gradient. Under the condition, prominent drawdown of [CO_2] around canopy layer is frequently observed. This drastic transition of the [CO_2] storage structure is of particular interest in the diurnal cycle of the stand-scale CO2 exchange between the ecosystem and atmosphere. Timeseries of the NEE shows seasonal pattern intrinsic to deciduous forest. The net CO_2 uptake shows rapid rise in May, the period of opening-leaves of Larch. During the non-foliated season, November to middle of April, the NEE is slightly positive and with small short-term variation. NEE in the growing season has significant short-term variability. Frequent reduction of light-availability due to passage of seasonal rain front likely constrain photosynthetic CO_2 uptake at the site. In this workshop, we will present results from our investigation about inter-annual variations in NEE and its relation to environmental controlling factors, about characteristics in gross component flux (GPP and RE), and about comparison of flux components with other flux sites.

P228

SEASONAL VARIATION OF CARBON DIOXIDE EXCHANGE AND ANNUAL CARBON BUDGET AT FUJIYOSHIDA FOREST SITE (FJY)

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[1] Hokkaido Research Center, Forestry and Forest Products Research Institute (FFPRI), Sapporo, Japan
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We have been observing CO_2 flux at 32m tower in evergreen coniferous forest in Fujiyoshida, Japan (AsiaFlux site code: FJY) since 1999. FJY is located in a temperate region in central Japan (35°27'N, 138°46'E, 1030m in elevation). Mean air temperature of recent 9 years (from 2000 to 2008) is 9.5°C and mean annual precipitation of 8 years (from 2000 to 2007) is 1955mm. The dominant species are *Pinus densiflora* in the upper and *Ilex pedunculosa* in the lower canopy with some deciduous broadleaf mixed. The soil is composed of volcanic lava partially covered with leaf litter and organic matter.

CO_2 flux measurement has been conducted by eddy covariance method using a three-dimensional sonic anemo-thermometer (SAT; DA600 or DA650, KAIJO, Japan) and an infrared gas analyzer (IRGA; LI6262, LI-COR, USA).

CO_2 flux (Fc) above the canopy and storage change (Sc) within the canopy were calculated every 30 minutes employing three-dimensional axis rotation (McMillen, 1988) and WPL correction (Webb et al., 1980). The raw data quality control procedures reported by Foken and Wichura (1996) and Vickers and Mahrt (1997) were performed in addition to the visual inspection. Then net ecosystem CO_2 production (NEP) was obtained from NEP = -(Fc+Sc).

Monthly mean air temperatures in winter (from December to February) were mostly below freezing point and the NEP values during that period were negative (i.e. carbon emission). NEP reached its peak often in May accompanied by an increasing solar radiation. High solar radiation continued during summer (from June to August) and air temperature was also higher than that of May.

Annual carbon assimilation ranged from 330 to 470gCm^{-2}(Figure). The largest annual NEP was obtained in 2005 and the monthly NEP in April and May of that year were much large compare to the other years. It suggests that the condition in the spring is especially significant for annual NEP.

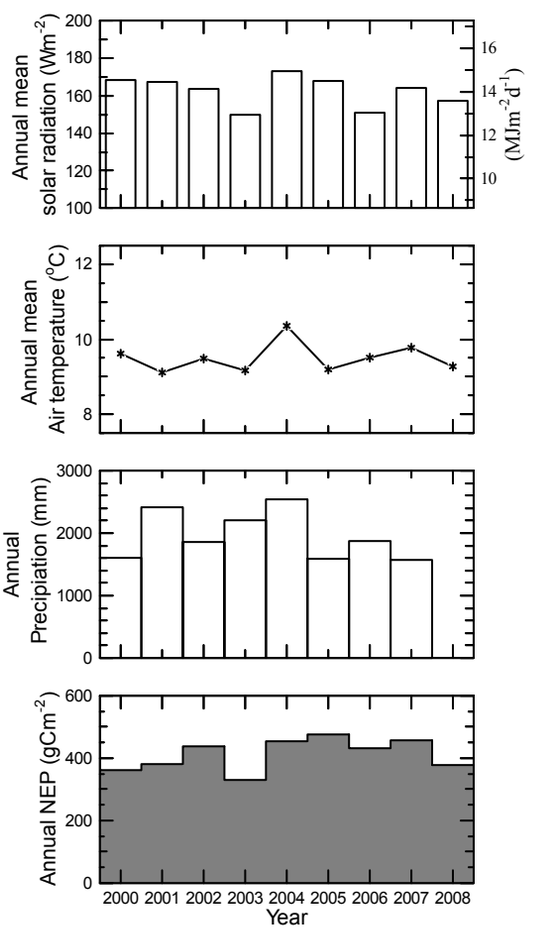

Figure Annual means of solar radiation and air temperature, and annual sums of precipitation and net ecosystem production from 2000 to 2008 at Fujiyoshida site. Precipitation was not available in 2008.

P229

A BIOGEOCHEMICAL FOREST MODEL FOR EVALUATION OF ECOSYSTEM SERVICES (BGC-ES) AND ITS APPLICATIONS

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Since human society is highly dependent on the ecosystem for various goods and services, evaluation of ecosystem services (ES) might be helpful in achieving harmony between human society and ecosystems. Previous studies have determined the monetary value of different ecosystem services on the basis of relatively simplified calculations. However, it is necessary to evaluate changes in ES under various conditions and scenarios. We developed a process-based biogeochemical model to evaluate the effects of forest management on forest ecosystem services (BGC-ES; Fig. 1) which consists of 4 submodels: biomass, water cycle, carbon and nitrogen (CN) cycles, and forest management. The biomass submodel can be used to evaluate the effect of forest management on ES.

In Japan, the forest ecosystem covers ca. 68% of the land; this is mainly attributable to the promotion of afforestation in the 1950–60s. However, these artificial forests cannot be adequately managed by the current Japanese forestry system, because domestic timber is losing its economic value due to international price competition. Economic market failure in Japanese forests resulted in the underuse of domestic forest ecosystems and overuse of overseas forest ecosystems. We focused on the Yahagi river basin (located in the Chubu region of Japan), large parts of which were covered by artificial forests; there is concern about insufficient forest management in this area (Fig. 2).

We collected datasets from both the natural and social environments. Forest inventories, yield tables, and forest maps were also collected from administrative agencies. Our GIS database includes the following parameters at stand-level. The parameters of the BGC-ES model were modified from comparing to flux sites, water quality of rain and mountain streams, and inflow of dam sites.

Using the parameterized BGC-ES model, we tried to evaluate the effect of forest management on the Yahagi river basin. The simulation was designed such that it represented the expected conditions 30 years later, and the results for the current (2003–2007) and a future (2033–2037) were compared under 4 scenarios: current forestry (low activity), standard forestry, long-term forestry, and no management. Compared with forests for which there is no management of the basin, forests where management was undertaken had higher amounts of absorbed carbon and runoff. In addition, the volume of harvested timber was larger and its quality (diameter) was better in forests where management was undertaken. These results indicated the importance of forest management for maintaining existing forests and enhancing forest ES.

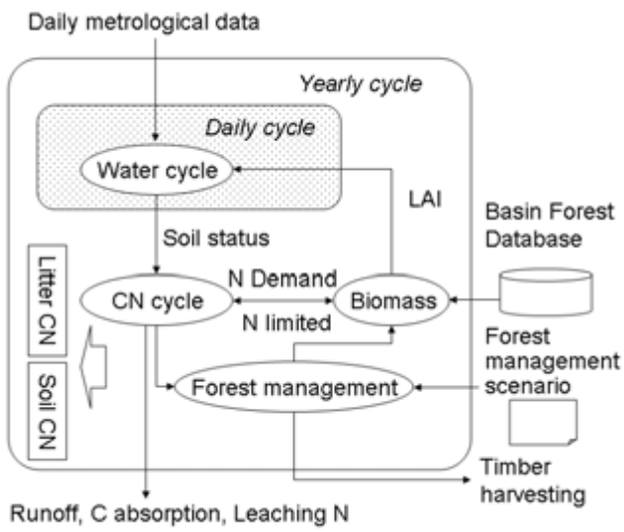

Figure 1 Schematic diagram of BGC-ES

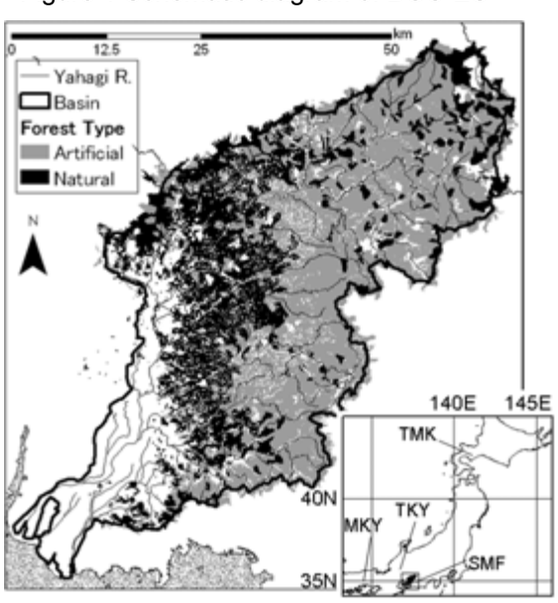

Figure 2 Oerview of the Yahagi river basin and the referred flux sites (TMK: Tomakomai, TKY: Takayama, SMF: Seto, MKY: Mikiyama)

P230

LEAF NUTRIENT CONCENTRATION AND RESORPTION OF 18 SPECIES IN AN ALPINE MEADOW ON QINGHAI-TIBETAN PLATEAU, CHINA

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In order to quantify the leaf nutrient concentration and resportion efficiency, detect how live-leaf nutrient status control nutrient resorption efficiency and compare the energy cost pattern in N and P acquisition, live and senescent leaf nitrogen (N) and phosphorus (P) concentrations of 18 species belonging to three different life forms (sedges, grasses and forbs) in an alpine meadow on the Qinghai-Tibetan Plateau were analyzed. Among the three life forms, sedges contained less N and P and had higher resorption efficiency than the other two groups. The average of the 18 species N and P resorption was 65.18% and 67.36%, respectively, which was at the high end of the values for a wide range of ecosystems. By fitting the allometric equations ($[\text{nutrient}]_{\text{senescent}} = A([\text{nutrient}]_{\text{live}})^{B}$) separately for N and P, we found the values of scaling exponents (B) for N and P were both significantly larger than 1, which indicated that with the increase of live leaf nutrient concentrations, nutrient resorption efficiency decreased, resulting from disproportionately more nutrient remained in senesced leaves as live leaf nutrient concentrations increased. The much smaller B of N than that of P implied that relative to the resorption from senescent leaves, the cost of N uptake from soils increased more quickly than that of P as resource availability decreased, probably due to inorganic N was not sufficient to meet plant N requirement in the alpine meadow ecosystem and with the decrease of nitrogen availability, plant tended to use organic N, however, the uptake of which might cost more energy than inorganic N. In addition, the resorption efficiency and proficiency of P, rather than N, could be predicted well by the N:P ratios of live leaves. On the basis of our findings and previous work, we speculate that the increasing nitrogen deposition (especially inorganic nitrogen deposition) will exert a great impact on nitrogen resorption and uptake processes of alpine meadow plants on the Qinghai-Tibetan Plateau.

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CHANGES OF CARBON FLUX IN A BROADLEAF DECIDUOUS FOREST BEFORE AND AFTER WINDTHROW DISTURBANCE

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An increase in various meteorological disasters is a major concern caused by global warming. Forest damage by windthrow due to typhoons is one of them. It is very important to clarify the influence of forest disturbance on CO_2 flux. In this study, CO_2 flux was measured by the eddy covariance method before and after the windthrow disturbance.

Sapporo Forest Meteorology Research Site (42°59´N, 141°23E, 180 m a.s.l.) is located on a gentle slope to the northwest on the outskirts of Sapporo city. The present forest was established after the wildfire in 1912, and is now at the transitional stage from an early-successional birch (*Betula platyphylla*) to mid- and late-successional species (*Quercus mongolica*, *Acer mono*, *Kalopanax pictus*, *Tilia japonica*, etc.). The mean canopy height was 21 m. The forest floor was dominated by dwarf bamboo (*Sasa kurilensis* and *S. senanensis*). It has a cool, temperate climate (Dfb) with an annual mean temperature of 6.5°C and an annual precipitation of 1100 mm. Snow cover reaches 1 m in depth and remains over 130 days. A 41 m height tower is located in the center of the forest, and the eddy covariance system is installed at 28.5 m height. An intense typhoon (200418) struck this site in September 2004. Many canopy trees were uprooted and snapped off by the strong winds. Most of the fallen trees have been left intact to allow the study of natural transition of the ecosystem. Maximum leaf area index was approximately 4 before the disturbance. The forest was largely destroyed, with a broken crown area estimated to be more than 50 %.

Seasonal and inter-annual changes in the monthly mean values of gross primary productivity (GPP), ecosystem respiration (Re) and net ecosystem productivity (NEP) before and after the disturbance are shown in Fig. 1. NEP was estimated to be −1.6–−2.0 gC m^{-2} day^{-1} in winter. In summer, NEP obviously decreased and GPP slightly decreased after the disturbance. In contrast, Re was the same or slightly increased in winter and conspicuously increased in summer. Annual carbon budgets are shown in Fig. 2. Before the disturbance, GPP and NEP were estimated to be 1239–1354 gC m^{-2} yr^{-1}, 256–399 gC m^{-2} yr^{-1}, respectively. Re was estimated to be around three-fourths of GPP. After the disturbance, NEP greatly decreased as compared to those before the disturbance. Annual NEP became negative in value after the disturbance. The reduction of NEP after the disturbance seems to be caused by a decrease in GPP and increase in Re. An increase in Re might have been caused by degradation of coarse woody debris. Although the canopy had been largely destroyed, the decrease in GPP was a small. The biomass change of the dwarf bamboo might have attributed to GPP.

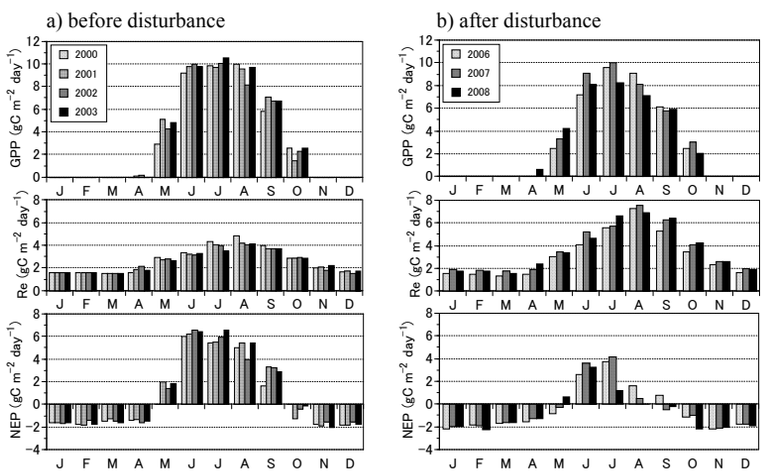

Fig. 1 Monthly mean values of GPP, Re and NEP before and after the windthrow disturbance.

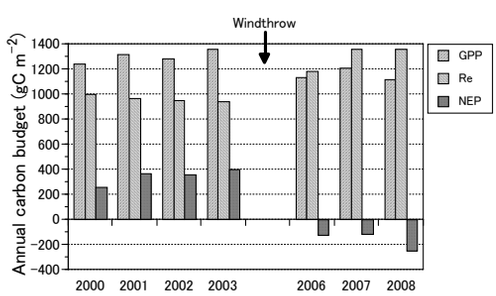

Fig. 2 Annual carbon budgets before and after the windthrow disturbance.

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WATER AND ENERGY EXCHANGE IN A BLACK SPRUCE FOREST IN INTERIOR ALASKA

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1. Introduction

Understanding the present water and energy cycles in the Arctic is a key for projecting future regional climate changes and their global implications. Documented recent changes to the Arctic terrestrial system include warming of permafrost, reduced lake and pond levels, and additional warming evidence, which in combination with a change in hydrology can affect greenhouse gas exchange. In the high latitude, the low precipitation, limited hydrological storage capacity due to the presence of permafrost and the abundant supply of snowmelt water control the ecosystem development, which affect the regional climate. Thus, it is necessary to quantify the water and energy budget for predicting the climate change. To clarify the response of water balance in a boreal forest to climate variation, we revealed the water and energy exchange in a black spruce forest in Interior Alaska using 6-year observed data.

2. Site and Observation

The observation tower is located in a black spruce forest in Fairbanks, Alaska (64°52N, 147°51W), that stands on discontinuous permafrost. The mean forest height is approximately 3 m and the mean forest age is 120 years (Vogel et al., 2005). The forest floor is covered with mosses, sedges and shrubs. The overstory canopy is open with leaf area index (LAI measured by LAI2000, Li-Cor) of 0.2 for black spruce, and LAI for understory vegetation is 2.0 for the growing season.

Fluxes of energy, CO_2 and water were observed using a sonic anemometer and open-path gas analyzer at 6 m above the ground. Micrometeorology such as net radiation, PAR, temperature gradient, wind profile, rainfall and soil heat flux were observed at and around the tower.

3. Results and Discussion

3.1 Energy Partitioning

After snow melted, larger fraction of available energy was partitioned into sensible heat flux (H), due to low transpiration limited by shallow soil thawing. Bowen ratio (BR) was approximately 2.0 in this period. With increase of thaw depth, vegetation became more active, and this resulted in more energy partitioned into latent heat flux (LE) during latter half of growing season (BR was approximately 0.7). Energy balance of this site during the growing season was typically close to 90% when heat storage in the soil above the soil heat flux plates was accounted for. It is also important to consider LE absorption during snowmelt period for closure of energy balance. This energy was typically 15 to 20% of available energy.

3.2 Water balance

The site climate is generally warm and dry in former half of growing season. During this period, water was supplied first by snowmelt (50-90 mm) and subsequently by soil thawing, and, as a result, evapotranspiration (ET) exceeds precipitation. Some of the snowmelt was used to saturate shallow layer of thawed soil, but the most was lost as runoff because of the shallow layer (up to 80 mm in this season). Peak of ET was observed around DOY 200 with maximum of 2.5 mm/day. Thereafter, ET started to decrease due to leaf senescence of annual plants despite increase of precipitation. Soil moisture content did not decrease in this period by the excess water and, subsequently, the water was preserved in the frozen ground to support the vegetation in the next early growing season. Total precipitation and ET was 327 mm and 246 mm, respectively, for hydrological year 2007, and 290 mm and 225 mm, respectively, for 2008. Consequently, the soil of the site remains sustainable condition under the current warming climate.

References

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TRANSPIRATION ACTIVITIES OF EVERGREEN TREES IN CENTRAL CAMBODIA: ABRUPT CHANGES REVEALED BY SAP FLOW MEASUREMENT

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Introduction

Evapotranspiration is one of the most important components of the water balance in forested watersheds in central Cambodia, where it was more than 70% of the annual precipitation (Kabeya *et al*., 2005; Nobuhiro *et al*., 2007). However, in this region, detailed transpiration activities have not been reported by any methods. From the results of sap flow measurements, we present tree-to-tree variations in seasonal changes in transpiration activities; especially focusing on the abrupt increase and decrease of transpiration measured at an evergreen species of *Drypetes*.

Materials and Methods

We measured sap flow by Granier method (Granier, 1985) within an evergreen broadleaf forest in Kampong Thom province, Cambodia (12°44'N, 105°28'E), where the 60-m-high observation tower had been built. The mean diameter at breast height (DBH) and tree height were 39.6 cm and 27.2 m, respectively (Nobuhiro *et al*., 2007). The meteorological data were measured on the tower.

Results and Discussion

This region located in the monsoon Asia: the wet season begins around the beginning of May and ends around the beginning of November (Fig. 1-C). The vapor pressure deficit was larger in the dry season (Fig. 1-B), while the net radiation was relatively constant through the year of 2008 (Fig. 1-A). *Calophyllum calaba* maintained its transpiration activity through the year of 2008 (Fig 1-D), however, *Drypetes* had abrupt increase and decrease in *q*: higher in wet season and lower in dry season (Fig. 1-E). Unfortunately, we had the lacks of measurement from March to April and from September to October in 2008, and thus we cannot determine the accurate date when *q* increased and decreased drastically. At the poster presentation, we will show rather continuous results obtained in 2009, and indicate the date of abrupt increase in *q* of *Drypetes* seemed to have occurred later than 2008.

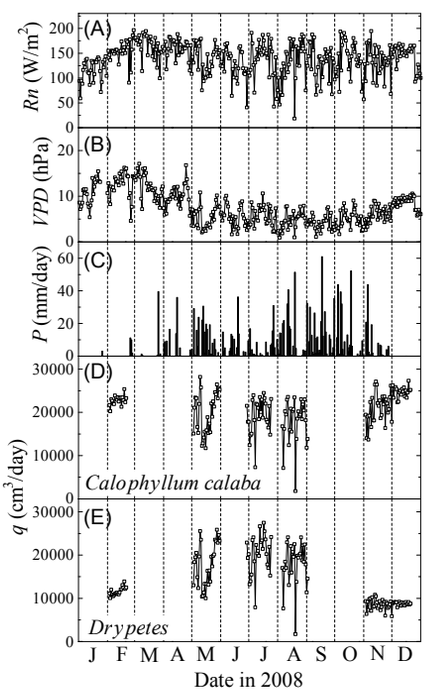

Figure 1 Seasonal changes in daily mean net radiation (*Rn*), vapor pressure deficit (*VPD*), daily amount of rainfall (*P*) and transpiration (*q*).

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P234

CARBON BALANCE OF REGROWING VEGETATION IN A LARCH FOREST AFTER A CATASTROPHIC TYPHOON DAMAGE

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1. Introduction

Typhoon is an important disturbance factor for forest ecosystems in East Asia. The disturbance affects ecosystem factors including biomass, vegetation composition and micrometeorology, and consequently changes their carbon cycles.

A plantation of Japanese larch (*Larix kaempferi* Sarg.) in Tomakomai, Hokkaido, Japan was destroyed by Typhoon Songda in September 2004, and red raspberry (*Rubus idaeus*) has dominated. In this study, we investigated the carbon balance of the regrowing ecosystem after windthrow.

2. Methods

The study site is located in southern Hokkaido, Japan (42°44'N, 141°31'E). Before the typhoon damage, this forest was a 45-year-old plantation of Japanese larch with some broad-leaved trees. After the typhoon, all stems of larch trees were removed from the forest floor for commercial use, whereas stumps and branches were left and *R. idaeus* has dominated.

Vegetation properties, such as above ground biomass (AGB) and leaf area index (LAI), were measured every one or two months from May or June through December in 2006 and 2007. Vegetation was harvested from 10 quadrats of 1 m^2 at every survey. Net ecosystem CO_2 exchange (NEE) was continuously measured using a multichannel automated chamber system from May or June through November in 2006, 2007 and 2008. The system comprised 6 chambers in 2006 or 4 in 2007 and 2008, and an infrared CO_2 analyzer (LI-820, LI-COR). The chambers were made of transparent PVC and cubic (0.9 m × 0.9 m × 0.9 m) in shape. All chambers were set on the ground including vegetation to measure NEE. Ecosystem respiration (RE) in the daytime was estimated from soil temperature at 0.01 m depth using an empirical model derived from nighttime NEE data. Gross primary production (GPP) was calculated as the difference between RE and NEE (GPP = RE - NEE).

3. Results and Discussion

Annual maximum AGB and LAI was 319 g m^{-2} and 3.7 m^2 m^{-2} in 2006, and 396 g m^{-2} and 3.9 m^2 m^{-2} in 2007. *R. idaeus* accounted for about 60% of AGB. Seasonal sums of NEE, RE and GPP were compared during the same period (from 29 June to 11 November) (Table 1). Annual difference in RE was very limited, but GPP varied annually, which resulted in annual variation of NEE. Seasonal variation of RE was accompanied by the variation of soil temperature (Fig. 1). The GPP in June was about twice higher in 2007 than in 2006. This is because LAI was higher in June 2007 than in 2006 with vegetation regrowth. There was little difference in NEE and GPP between 2006 and 2008 (Table 1). However, it is thought that annual GPP was higher in 2008 than in 2006 because GPP during the early growing season in 2008 was considered to be as high as in 2007. Hence it is thought that NEE had decreased with vegetation growth after typhoon damage.

Table 1 Seasonal sums of NEE, RE and GPP, and maximum AGB and LAI

	Period	NEE	RE	GPP	AGB	LAI
		gC m^{-2}	gC m^{-2}	gC m^{-2}	g m^{-2}	m^2 m^{-2}
2001 - 2003	Jun. 29 - Nov. 11	-152	982	1134		
2006	Jun. 29 - Nov. 11	101	561	461	319	3.7
2007	Jun. 29 - Nov. 11	39	562	525	396	3.9
2008	Jun. 29 - Nov. 11	100	557	459		
2006	Jun. 10 - Nov. 16	119	632	514		
2007	May 8 - Nov. 11	-34	764	800		
2008	Jun. 28 - Nov. 20	104	565	462		

NEE, RE and GPP from 2001 to 2003 were measured with the eddy covariance method.

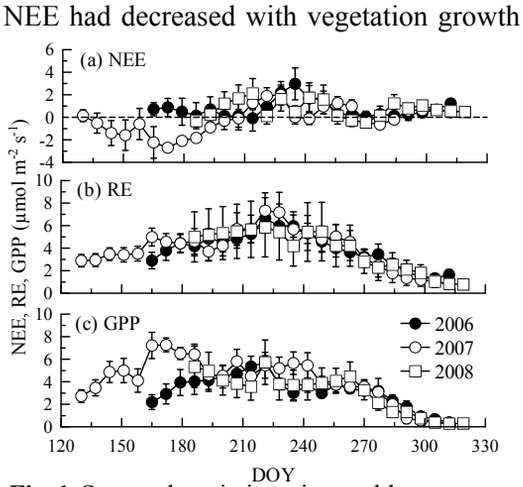

Fig 1 Seasonal variations in weekly average of NEE, RE and GPP

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SEASONAL COURSE OF HEAT AND WATER VAPOR FLUXES MEASURED OVER A LOWLAND EVERGREEN FOREST IN CAMBODIA

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Introduction Water exchange process within and above a tropical forest in southeastern Asia draws widely attention, from the viewpoint of the distribution of water between nations and its interaction between global climate change. Lowland evergreen forest is one of the most common vegetation types in the region, and naturally flourished there; however, it has been diminishing because of the human developmental pressure. We have operated flux measurement over a lowland evergreen forest in Cambodia, where the natural forest is relatively preserved. Applying band-pass eddy covariance method, the measurement successfully continued 11+ months. In this study we show the results of heat and water vapor exchange above the forest, discussing the characteristics of heat budget in dry and wet seasons.

Site and Methods Flux measurement was carried out using a 60-m-high observation tower built in the O Thom I watershed (12° 44' N, 105 ° 28' E), in Kampong Thom province, central Cambodia. The tower is surrounded by evergreen broadleaf trees, and the terrain is rather flat. Band-pass eddy covariance instruments, a sonic anemo-thermometer (K-probe, ATI, USA) and a ventilated thermo-hygrometer (HMP45D, Vaisala, Finland) were installed at the top of the tower. The measurement was made from July 28, 2008 to July 4, 2009. The data were collected at the rate of 10Hz using a data logger (CR1000, Campbell, USA). Vertical fluxes were calculated for each 30 minutes, after the transducer shadow correction (Kaimal et al., 1990) and the coordinate rotation which makes *w* equal to zero (Kaimal and Finnigan, 1994), where *w* is vertical wind velocity component.

Results Figure 1(a) and 1(b) are diurnal variations of hourly sensible heat flux (H) and latent heat flux (LE) averaged in DOY 245-274, 2008 (corresponding to wet season) and in DOY 40-69, 2009 (corresponding to dry season), respectively. The average values of H and LE became lower in the wet season. The larger LE in the dry season would be caused by the water uptake function of deep root system of this forest (Ohnuki et al., 2008) and the larger net radiation and vapor pressure deficit (Nobuhiro et al., 2007). Meanwhile, the value of LE/H was larger in the wet season, suggesting the wet environment condition promoted the larger distribution of effective energy to LE components, evaporation and transpiration. In the presentation, this kind of analysis will be expanded using the 11+ months' data, with examinations of sensor degradation effect and energy balance closure.

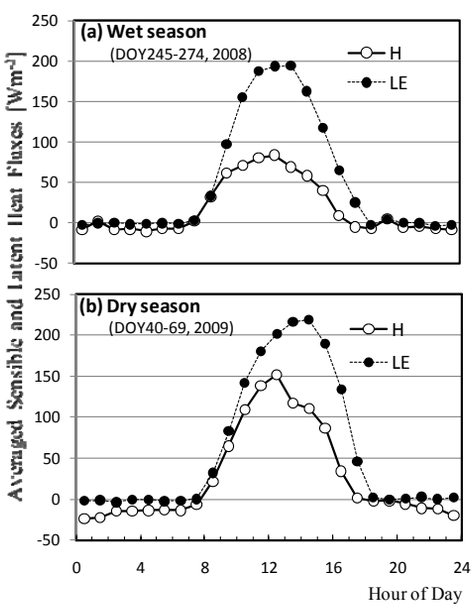

Figure 1: 30-day average of hourly heat fluxes above the evergreen forest in Cambodia; (**a**) wet season and (**b**) dry season.

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UP AND DOWN FLOWS IN THE CANOPY ON THE SLOPE AND VARIATION OF CO2 CONCENTRATION AT TKY

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TKY site is located at 36º 08' 46.2" N, 137º 25' 23.2" E in the central part of Japan. This site is in the complex terrain. There are two flux towers in TKY area; one is located at the top of hill, the elevation of which is 1420 m (Top tower). Another tower was built in 2006 in a small valley; approximately 100 m west and 40 m down from the old tower. The height of the second tower is 20 m, and the tower is entirely inside the canopy (Valley tower). Over story dominant species at TKY are *Betula* and *uercus crispula* with *Sasa senanensis* at under story.

We observe CO_2 concentration at 6 levels and CO_2 flux with the closed path method on the Top tower (Saigusa et al., 2002) and three levels on the Valley tower. Since TKY is located in complex terrain, night time NEE may be underestimated, and the effect of advection may not be negligible, particularly at night. During the night from 8 to 9, Oct, 2008, intensive observation was conducted throughout the night. In this period, upslope wind continued until 1:30 a.m. on 9, Oct., then the wind direction changed to down slope wind. In the period of up slope wind, the concentration of CO_2 was stable and not so much time variant at all the levels. The concentrations were close to each other except for that of the lowest level of Top tower (2 m), suggesting the flow was well mixed even at midnight. After the wind direction changed to down slope wind, CO_2 concentration at the lowest level of Valley tower (3 m) became much time variant, suggesting the flow inside the canopy was intermittent. The canopy structure near the Valley tower is relatively low LAD between 2 to 10 m. Down slope wind often had the maximum around 6 to 10 m above the ground. Temperature in the canopy under down slope wind often had the minimum near the maximum of down slope wind. The high concentration of CO_2 was usually limited below 6 m near the Valley tower. Radon concentration, which is a tracer gas emitted from soil, was also observed and the results are shown in another presentation (Murayama et al.) in this workshop.

Reference

Saigusa,N. S. Yamamoto, S. Murayama, H. Kondo and N. Nishimura 2002: Gross primary production and net ecosystem exchange of a cool-temperate deciduous forest estimated by the eddy-covariance method, *Agric. Forest Meteor.*, **112**, 203-215.

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DETECTING A DIFFERENCE IN PHENOLOGICAL STATUS USING SCALAR DISSIMILARITY OBSERVED ABOVE THE FOREST CANOPY

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Surface-layer similarity theory (Monin–Obukhov similarity theory), which assumes stationarity and horizontal homogeneity, is not always realised due to failure in the assumption above a vegetation surface, especially forest canopy. Possible causes of this failure are the boundary layer flow condition, such as mesoscale, on one hand, and an inhomogeneous source/sink distribution inside the canopy, on the other. The latter is caused by canopy structure and physiological activity, which vary with plant phenology.

This study used observation of the air temperature, humidity, CO_2 concentration, and wind speed above various types of forest canopy to investigate the influence of plant phenology on the similarity relationship between these variables, focusing on foliar physiological processes such as photosynthesis and transpiration. Data were obtained from five forest sites: deciduous conifer and evergreen conifer boreal forests (Yakutsk, Russia), cool-temperate mixed forest of evergreen conifer and deciduous species (Moshiri, Japan), and warm-temperate mixed forest of evergreen and deciduous broadleaf species (Seto, Japan). Using high frequent measurements of air temperature (T), humidity (q), CO_2 concentration (c), and wind speed, the correlation coefficient and relative transfer efficiency for each pair of scalars was evaluated for 30-minute periods.

The correlation coefficients and relative transfer efficiencies for T–q and q–c approached unity during summer and departed from unity during the other seasons. The same trend was observed at all forest sites, although the amplitude of the variability differed. The boreal and cool-temperate sites showed larger variability compared to the warm-temperate forest site. As a specific case, comparing the seasonal variation of boreal deciduous (larch) and evergreen (pine) forests located near each other, the similarities of the water vapour and CO_2 concentrations were variable, whereas the similarities of the wind speed and air temperature remained stable over 6 months from April to September. At midsummer, the difference between the two sites became small, and the scalar showed similar variation. These findings indicate that the scalar similarity of these two forests is caused mainly by physiological processes, rather than by changes in physical structure.

P238 SENSITIVITY ANALYSIS FOR EPPML MODEL

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Ecosystem Productivity Process Model for Landscape (EPPML) is developed based on Forest-BGC, BEPS and Biome-BGC models. It can be used to simulate carbon and water fluxes in forest and grassland ecosystems. Carbon (C) fluxes and water fluxes are linked by stomata in this model. EPPML has been tested well when used in the Changbai Montain and Xilin river basin, Inner Mongolia. But systematic sensitivity analysis for the model parameters has not been conducted yet. During sensitivity analysis, some key parameters can be detected through observing the ranges of change in carbon and water fluxes when parameters increase or decrease at a lower rate. So sensitivity analysis is of great benefit to model development and application. In this study, we first used the recently improved EPPML model to simulate net ecosystem productivity (NEP), ecosystem respiration (RE) and gross primary production (GPP) for *Pinus massoniana* stand in Qian Yanzhou in 2003 and 2004, and then conducted sensitivity analysis for almost all the parameters in EPPML.

The simulated GPP, NEP and RE were calibrated by the data obtained by eddy flux observations. The annual NEP was 0.322 kgC/m2/a in 2003, and 0.380 KgC/m^2/a in 2004, which indicated that the stand was a stronger carbon sink. In 2003, there occurred peaks for GPP, RE and NEP was in June and September, respectively. But GPP, RE and NEP decreased most significantly from June to July, and NEP was only -0.00029 KgC/m^2/d in July because of high temperature and drought. The annual total precipitation became normal in 2004, and net carbon absorption capacity was higher than in 2003. But in the earlier growing season, NEP was still lower, that was the performance of hysteresis of sever drought in 2003. NEP reached to the highest value 0.00211 KgC/m^2/d in July, 2004.

Parameter sensitivity analysis methods available now mainly include local and global sensitivity analysis. In local sensitivity analysis, two different methods were chosen, and they were factors change method and deviation change method, respectively. And in global sensitivity analysis, Morri's method was chosen.

In the local parameter sensitivity analysis, the chosen two different methods got the same conclusions about parameter sensitivity. It showed that sensitivity method in local sensitivity analysis affected little. The parameters having the greatest influence on NEP were maximum RuBP carboxylation rate at 25˚C, the maximum leaf nitrogen (N) content, average leaf N content and the plant C content. The soil water storage layer depth, soil water content, wilting coefficient, and leaves, branches, stem and root growth respiration fraction had some influence on ecosystem respiration. The maximum, optimum and minimum temperature for stomatal opening had the least influence on NEP. Among the inputted meteorological data, temperature had the greatest influence on NEP, secondly precipitation and sunshine time. Wind speed did not have significant effect on NEP.

The global sensitivity analysis showed that the influence of single parameter on NEP was the same as that in the local sensitivity analysis; but in the sensitivity analysis with more than two parameters, the combined change in the maximum RuBP carboxylation rate at 25˚C, the maximum leaf N content, average leaf N content, and soil water content at plant root layer had the greatest influence on NEP. The combined change in temperature and precipitation had also significant influence on NEP. That was the reason why NEP was lower in July, 2003 with higher temperature and drier weather than that in July, 2004 with normal heat and water conditions.

The model parameter sensitivity analysis can be helpful in predicting the changes in NEP as well as in detecting key parameters, and is also the basis of uncertainty analysis, which will be conducted in the near future study.

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SEASONAL AND ANNUAL VARIATION OF CH_4 FLUX FROM A RICE PADDY FIELD IN JAPAN

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CH_4 is an important greenhouse gas with the global warming potential about 20 times greater than CO_2. Since CH_4 is produced in anaerobic soil by microbial activities, numerous measurements of CH_4 flux (F_{CH4}) has been made in inundated ecosystems such as natural wetlands and rice paddy fields since the 1980s. Flux chambers are often used in those measurements, but the chamber method is not suitable for measuring F_{CH4} continuously on a field scale and under non-disturbed conditions because of limitations of the methodology. Thus, seasonal and annual variations of F_{CH4} are not fully understood, and estimates of amounts of CH_4 emission from wetland ecosystems have large uncertainties. In this study, we used the gradient method to measure F_{CH4} at a rice paddy field. It enabled us to measure F_{CH4} continuously on a field scale and under non-disturbed conditions, and provided reliable information about the seasonal and annual variations of F_{CH4} and the total amount of CH_4 emission from the field.

The Mase flux site is one of the AsiaFlux monitoring sites located in the Kanto plain in Japan. The site is managed as a single-rice cropping filed, where seedlings of rice (Koshihikari) are planted in early May, and grains are harvested in middle September. The water depth in the growing season was about 0.05 m except for the following drainage periods: mid-season drainage, which is practiced to control rice growth, and the final drainage as preparation for harvesting. The water depth is zero during those drainage periods.

CO_2 flux (F_{CO2}), sensible heat flux (H) and friction velocity (u_*) were measured at 3.1 m height using the eddy covariance (EC) system (DA-600, Kaijo, and LI-7500, Li-cor). F_{CH4} was calculated as: $F_{CH4} = D_f * dCH_4$, where D_f is the diffusion velocity derived from H, u_* and aerodynamic parameters, and dCH_4 is the CH_4 concentration difference between 3.8 and 1.4 m measured by using a FID-type CH_4 analyzer (APHA-360, Horiba). To calculate F_{CH4}, well qualified EC data were selected. In addition, to validate the gradient method approach, F_{CO2} measured by the EC ($F_{CO2\text{-}EC}$) and by the gradient method ($F_{CO2\text{-}GD}$) were compared. If the difference between $F_{CO2\text{-}EC}$ and $F_{CO2\text{-}GD}$ was larger than a certain threshold, F_{CH4} at that time was discarded because the large difference between $F_{CO2\text{-}EC}$ and $F_{CO2\text{-}GD}$ indicated meteorological conditions were not suitable for applying the gradient method. In this paper, we focus on F_{CH4} during the rice growing period from 2003 to 2005, though we have nearly continuous data of F_{CH4} from 2002 to 2007.

An exponential relationship with high correlation coefficient was found between F_{CH4} and soil temperature at 0.05 m depth when the whole year dataset was divided into sub-datasets according to LAI interval of 1 m^2 m^{-2} and the presence of water. Missing dada of F_{CH4} were estimated from the soil temperature using the exponential functions when more than three consecutive data were missing, or filled using the linear interpolation in the other cases. Continuous measurements revealed distinct seasonal variation of F_{CH4}. It was close to zero in May, and gradually increased to peak levels (ca. 0.3 g C m^{-2} d^{-1}) from June to July. During the mid-season drainage, even though in July, F_{CH4} decreased dramatically and kept low values because aerobic conditions in soil suppressed methanogenesis and enhanced CH_4 oxidation. Another remarkable phenomenon was a large flush of CH_4 emission (ca. 0.7 to 1.2 g C m^{-2} d^{-1}) at the beginning of the final drainage. This could be explained mainly by the removal of water, which released CH_4 accumulated in soil during the growing period at once. The total amounts of CH_4 emission during the rice growing period of 2003, 2004 and 2005 were 20, 19 and 11 g C m^{-2}, respectively. Those amounts were approximately 3% of F_{CO2} in respective years, indicating CO_2 cycle also regulated CH_4 emission through enhancement of organic exudates and transport capacity with rice growth. The lowest CH_4 emission in 2005 was attributed to the long mid-season drainage in July and relatively low temperature in summer. This suggests that CH_4 emissions from the rice paddy could be partially controlled by adjustment of the timing and length of mid-season drainage.

P240

TRANSPORTATION OF CO_2 AT TKY SITE OVER A MOUNTAINOUS COMPLEX TERRAIN ESTIMATED FROM ATMOSPHERIC ^{222}Rn MEASUREMENT

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Measurements of CO_2 flux between the terrestrial ecosystem and the atmosphere have been made at many sites using eddy covariance method. However, the uncertainty in the estimation of net ecosystem exchange (NEE) of CO_2 under stable nighttime conditions has been pointed out, especially over complex terrain, resulting in underestimation of nighttime ecosystem respiration. ^{222}Rn is a natural radioactive noble gas emitted from soil with a half life of 3.82 days, which has been used as a tracer of atmospheric transport processes. Therefore, atmospheric ^{222}Rn concentration measurement is also expected to be useful to examine CO_2 transport processes over a complex terrain. For this purpose, measurement of atmospheric ^{222}Rn was initiated at Takayama deciduous forest site (TKY; 36.15°N, 137.42°E, 1420 m a.s.l.); this is one of the longest flux monitoring sites in the FLUXNET network, over mountainous complex terrain in central Japan.

Continuous measurements of vertical CO_2 profiles, as well as of CO_2 fluxes and meteorological parameters, were made at two towers, one on the ridge and another one on the slope; the distance between the two towers was about 100 m. ^{222}Rn measurement was also made at both of the towers using an electrostatic method with a PIN photodiode.

In the growing season, prominent CO_2 diurnal cycles with a maximum during the nighttime and a minimum in the early afternoon were observed, consistent with the biological activities, while ^{222}Rn showed a complicated diurnal variation. However, the following relationships between ^{222}Rn and topographical winds were found: (1) With upslope wind, ^{222}Rn at the ridge tower tended to increase due likely to an accumulation of ^{222}Rn emitted from the soil in the airmass flowing upward along the slope. (2) With downslope wind, ^{222}Rn at the slope tower tended to increase due likely to an accumulation of ^{222}Rn emitted from the soil in the airmass flowing downward along the slope. This increase in ^{222}Rn occurred only near the ground surface. During the periods when higher ^{222}Rn values were observed at the slope tower, the CO_2 concentrations were also observed to be higher at the slope tower than at the ridge tower, indicating a downslope transport of respiratory CO_2 emitted near the surface.

Using the observed ^{222}Rn and wind data and the ^{222}Rn flux from soil estimated from an empirical equation at TKY, each component of the ^{222}Rn budget (i.e., the eddy vertical transport, the advective transport and the storage) in the canopy layer was estimated for the nights when the downslope winds were observed, followed by a calculation of the effective eddy diffusivity (K). Using the CO_2 concentration, wind data and the obtained K, each component of the CO_2 budget in the layer was also estimated.

From the analyses, it was found that components of vertical eddy and advection along the slope are larger than the storage component in ^{222}Rn and CO_2 budgets. The advective component tended to be enhanced when downslope drainage flows occurred. Prominent drainage flows were observed in 17 nights out of 32 nights during the intensive campaign in the fall of 2008. Over the 17 nights, CO_2 transported due to the advection along the slope was estimated to be about 70% of respiratory CO_2 emitted to the inside of the canopy on average, while about 40% of ^{222}Rn emitted from the ground surface was transported in parallel to the slope. Such a difference reflects difference of vertical profile between CO_2 and ^{222}Rn in the canopy layer; this may be attributed to the fact that respiratory CO_2 is emitted not only from soil but also from above-ground parts of plants, while ^{222}Rn sources are located only in soil.

P241

A STUDY OF CO_2 VARIATIONS RELATE WITH TEMPERATURE AND VAPOR AT DIFFERENT TIME SCALES DURING MAIZE GROWTH SEASON IN NORTH CHINA PLAIN

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Based on high-frequently measurement data of temperature, CO_2 and water vapor density by eddy covariance system, which was mounted at 16 meters over maize fields in North China Plain, we do the correlation analyses in hourly, daily and 10-day scales respectively. The results indicate that, there are always strong negative correlation ships between CO_2 concentration and temperature on all the scales. While, the correlation between CO_2 and water vapor is just significant at hourly and daily scale, not evident at 10-day scale. With the prolonging of time scales, the negative correlation coefficients of temperature and water vapor are deceasing, and the positive relations are increasing, only appear positive correlation ship at 10-day scale. Further study is conducted to the correlation ship between CO_2 flux and the scalars of temperature and water vapor density at half-hourly scale. Results indicate that the correlation coefficients hold negative diurnal cycle during the growth period of maize, and the scope of the diurnal cycle is sensitive to the growth of plants.
Key words: maize, CO_2 concentration, temperature, water vapor, the correlation ship.

P242
TRACING THE TRANSFER OF RECENTLY ASSIMILATED CARBON INTO THE SOIL AFTER *IN SITU* $^{13}CO_2$ PULSE LABELLING OF TREES

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The fate of carbon in the soil plant system was followed by using pulse-labelling of 10 m tall trees in the field with $^{13}CO_2$ for a short period of time (Figure 1). The study is conducted on three tree species (beech, oak and pine) that are among the major species in European forests. Trees are labelled at three distinct phenological phases during the growing season. The assimilated ^{13}C by plants during the pulse labelling was then tracked in soil CO_2 efflux with a high temporal resolution using tuneable diode laser absorption spectrometry (Plain *et al.* 2009) and in the microbial compartment from soil cores (root + mycorrhiza transfer) and in mesh cores that permit the ingrowth of mycorrhiza hyphae but exclude roots (no-root cores).
Labelling experiments were done between Sept 2008 and August 2009. Recovery of ^{13}C in soil CO_2 efflux was observed a few couple of hours after the beginning of the labelling in oak and beech. There is a rapid transfer of ^{13}C belowground with a maximum occurring within 2 to 4 days after labeling.

Fig. 1: Labelling chamber on a beech tree (Sept. 2008)

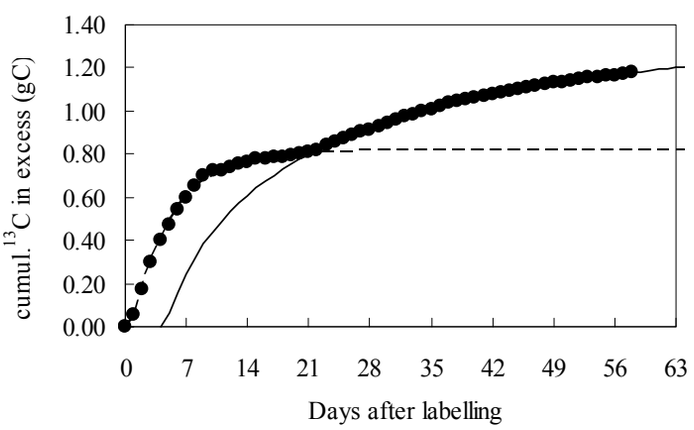

Fig. 2: Cumulative label recovered in soil CO_2 efflux in beech tree (Sept 2008)

Maximum recovery occurred earlier in beech and oak, while it happened later in Pine. The cumulative ^{13}C in excess in soil CO_2 efflux was well fitted with a sum of the integrals of two exponential decay functions, with a half-life of 3–5 days for the first exponential and a half-life of 16–18 days for the second (Figure 2)

The maximum labelling in the microbial biomass was observed 2 to 3 days after labelling in beech, almost at the same time than in the fine root, indicating a fast transfer of photosynthate to the microbial community, with almost no ^{13}C detectable in the bulk soil or in non fumigated soil extracts. ^{13}C enrichment is also observed in root exclusion cores highlighting the fact that not only roots but also mycorrhiza are involved in the transfer of C into forest soils. These findings reinforced previous results showing a close coupling between photosynthesis and soil CO_2 efflux and might help resolving steps and processes involved in this coupling.

Plain C, Gérant D, Maillard P, Dannoura M, Dong Y, Zeller B, Priault P, Parent F, Epron D. 2009. Tracing of recently assimilated carbon in respiration at high temporal resolution in the field with a tuneable diode laser absorption spectrometer after in situ $^{13}CO_2$ pulse labelling of 20-year-old beech trees. Tree Physiology, under press

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THE δ ^{13}C COMPOSITION OF RESPIRED CO_2 FROM ROOTS AFTER $^{13}CO_2$ PULSE LABELLING

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To quantify the amount of carbon which is allocated to root growth and root respiration in maritime pine and beech, short term pulse labeling were done using almost pure $^{13}CO_2$ (99%) during the growing season. The research was conducted on beech (*Fagus sylvatica*) in the state forest of Hesse (48°40′40″N, 7°04′05″E, 300 m elevation) and on pine (*Pinus pinaster*) in the INRA domain of Pierroton (44° 45' N, 0° 42' W, elevation 60 m) in France. A 0.5-0.6m deep trench was dug around each tree in Nov. 2008, lined with a polyethylene film and filled back. This delineates a 2m×3m area where only roots of the target trees are alive. The labeling experiments were conducted between September 2008 and August 2009 using a 40m^3 poly-amide chamber which covered the whole tree crown. At each labeling experiment, two trees were labeled and one tree remained as control tree.

After labeling experiment, branch, stem, soil and root CO_2 effluxes and their isotope composition were measured by tunable diode laser absorption spectroscopy with a trace gas analyzer (TGA 100A; Campbell Scientific) coupled to flow-through chambers (Plain *et al* 2009). To measure intact root respiration, the soil contained in the chamber volume to a depth of 0.1 m (cross sectional area =380cm^2) was carefully removed, leaving only the living roots. A polycarbonate board was inserted under root to exclude contribution to respiration from the soil beneath the chamber base. The removed soil was replaced with an equal amount of sterilised sand that was similar to the original sandy soil. ^{13}C recovery in root and soil respiration was also measured by incubating root and root free soil sorted from soil cores collected at different dates after labeling.

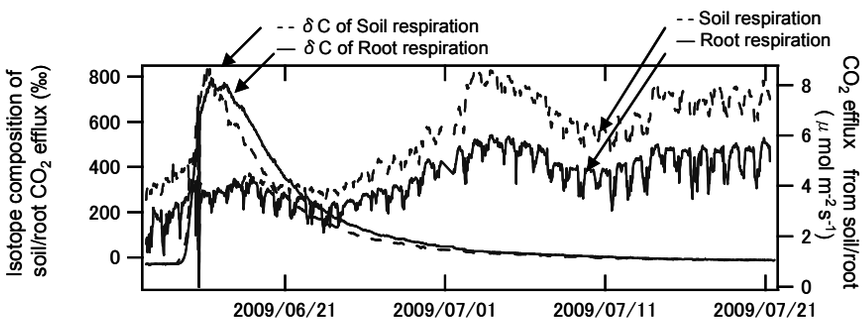

Fig.1 Soil and root CO2 effluxes and those isotope compositions in *Pinus pinaster*

Fig.1 showed soil and root CO_2 effluxes and those isotope compositions in pine after a labeling done in 12 June 2009. The signal arrived to soil 1.8-3 day after labeling. The average speed of carbon flow along the pine tree was calculated 0.14 and 0.15m/h in June labeling and 0.10 and 0.11 m/h in August labeling (Fig.2). This speed was lower than that of beech (0.5 - 1 m/h). Using two chambers for root of pine, the speed of transport C through the coarse root could be estimated to 0.08m/h in August.

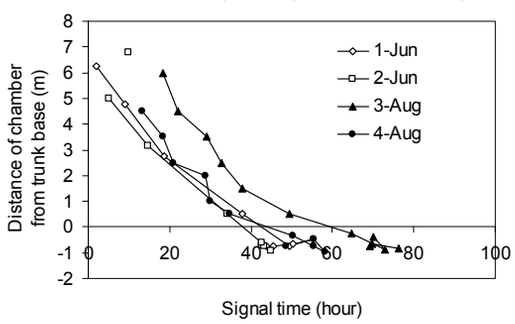

Fig.2 the spped of carbon flow in *Pinus pinaster*

Plain C, Gérand D, Maillard P, Dannoura M, Dong Y, Zeller B, Priault P, Parent F, Epron D. 2009. Tree Physiology, under press

P244

A LAND SURFACE MODEL VALIDATION AT A SITE IN TROPICAL CLIMATE WITH REMARKABLE DRY AND RAINY SEASONS

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The objective of this study is to validate the land surface model (Iso-MATSIRO) in tropical monsoon climate where the partition of rainy and dry seasons is remarkable at Tak flux measurement site (TFM; 16°56˚N, 99˚25'E) in Thailand. In particular, we focus the impacts of soil hydraulic properties on reproducibility of simulated soil moisture (SM) and evapotranspiration (ET).

Offline runs using Iso-MATSIRO model, with stable water isotope physics embedded, were manipulated for year 2003 with in situ surface meteorological observations to reproduce the large evapotranspiration measured during dry season, and particularly to examine the impact of soil hydraulic properties on water balance. We found that the results were very sensitive to soil hydraulic properties, especially to saturated hydraulic conductivity. In addition, two different parameterizations of soil hydraulic properties (main difference of two parameterizations is exponential variation in hydraulic conductivity and matric potential particularly when soil is dry, i.e., more sudden change in VG80 than CH78), with the same soil texture class from Global Data Task (IGBP-DIS, 2000), both most of the time captured well the observed seasonal evolution of total evapotranspiration during both dry and wet seasons as shown in Fig. 1. However, during dry season ratios of soil evaporation (E_s) and transpiration (E_t) to total evapotranspiration were significantly different between the two parameterization runs. With VG80 parameterization transpiration dominated but with CH78 evaporation from soil surface was dominant. We don't have any observed value of partition of ET so we will not be able to validate the partition of ET. Stable water isotope [$H_2{}^{18}O$ and/or HDO, known as $\delta^{18}O$ and δD, respectively] measurements should help distinguish between evaporation and soil transpiration. The isotope ratio simulated by Iso-MATSIRO showed linear relation between isotope ratio in surface SM and soil evaporation and constant large difference between isotope ratio for transpiration and soil evaporation, which suggest the possibility to divide the partition of ET by stable water isotope observation as shown in Fig. 2. The stable water vapor isotope ratio observation might be expected for clarifying such process.

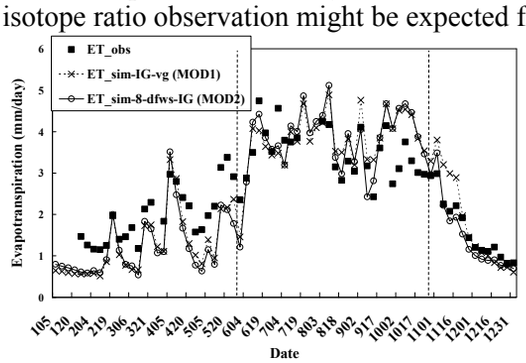

Fig.1: Comparison of 5-day mean simulated evapotranspiration (ET) for modified SHPs experiments with observed ET.

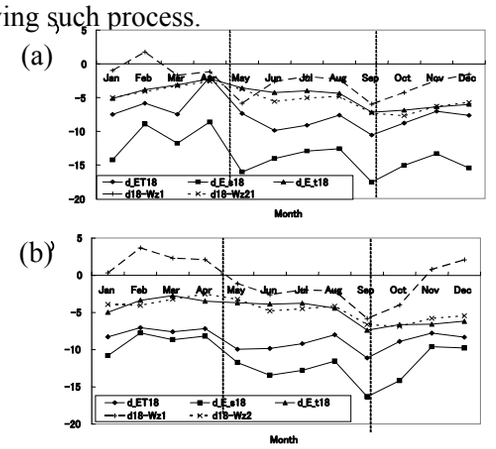

Fig.2: Comparison of simulated monthly mean stable water isotope ratio for ET, E_s, E_t, SM at 1st and 2nd layers for (a) VG80 (b) CH78.

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SIMULATIONS OF CARBON-ISOTOPE DISCRIMINATAION ABOVE AND WITHIN A FOREST CANOPY

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Fluxes and concentrations of carbon dioxide and $^{13}CO_2$ provide information about ecosystem physiological processes and their response to environmental variation. A multi-layer model for CO_2 and H_2O exchange in a C3 plant community was used to investigate several aspects of carbon isotope exchange between a forest ecosystem and the atmosphere from the leaf scale to the forest scale. We tested the influence of physiological parameters, and the canopy structure on whole canopy carbon-isotope discrimination.

The multi-layer model that we used computes above canopy fluxes based on detailed processes (Reynolds stress, sensible heat exchange, CO_2 and water vapor exchanges of leaves and the ground surface, radiative transfer within the canopy, atmospheric diffusion within an above the canopy, the energy balance of leaves and the ground surface, the interception of rainfall and the budget of leaves) characterized by the canopy structure and the biochemical processes, considering patchy stomatal behavior. Observations were conducted at the Pasoh Forest Reserve(2°58' N, 102°18' E). The core area (600 ha) of the reserve is a primary lowland mixed dipterocarp forest, consisting of various species of *Shorea* and *Dipterocarpus*. The continuous canopy height is approximately 35 m, although some emergent trees exceed 45 m. In order to parameterize a leaf submodel of the forest model, we measured gas-exchange characteristics at the scale of leaves with a leaf chamber and at the scale of a whole forest with eddy covariance method. We scaled gas exchange from leaf level to a canopy using the information of a canopy structure, such as a profile of leaf area index, a distribution of leaf inclination angle, clumping index.

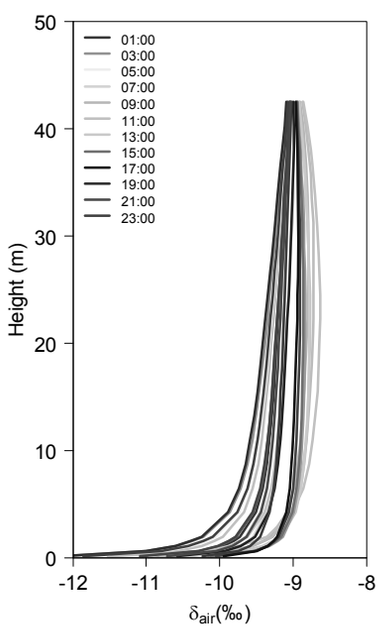

Figure 1
Profiles of the simulated carbon isotope ratio of CO_2 in the air.

Simulated carbon isotope ratio of CO_2 in the air (δ_{air}) was more negative at the bottom of the canopy and at the nighttime (Fig.1). Differences of simulated carbon isotope ratios of the assimilated carbon (δ_{plant}) between upper and lower canopy were approximately 3‰ (Fig.2).

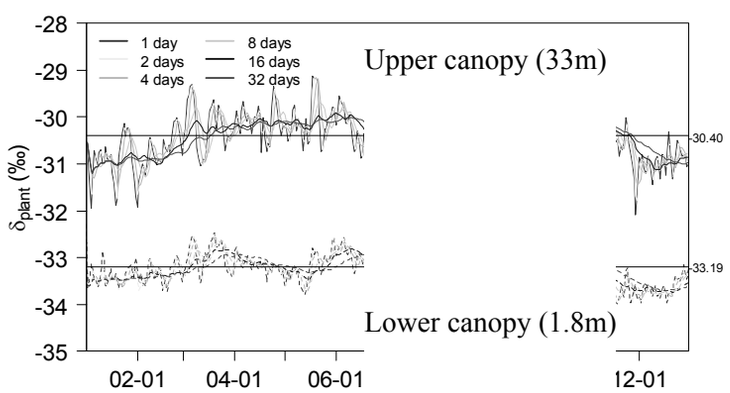

Figure 2
Seasonal variations in the simulated carbon isotope ratio of the assimilated carbon at two different levels. The average values are presented at the right axis.

Poster II

P246

ISOPRENE FLUX MEASUREMENT USING RELAXED EDDY ACCUMULATION METHOD IN WARM-TEMPERATE MIXED FOREST IN JAPAN

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Poster II

Biogenic Volatile Organic Compounds (BVOCs) including isoprene (C_5H_8), monoterpene ($C_{10}H_{16}$), alcohols, organic acids and aldehydes are released from many plant species. It is estimated that the global emission of BVOCs ranges from 500 to 1200 Tg carbon per year. Global emission of isoprene accounts for about 50 % of total BVOCs emission. Isoprene is known as substantial precursors of tropospheric ozone and organic aerosol, and for that reason, atmospheric isoprene has a significant impact, and indirectly effects to global warming. Furthermore, neglect of isoprene from vegetation causes the overestimation of carbon sequestration in the forest. While isoprene emissions may be small in terms of gross primary production (GPP) and net primary productivity (NPP), the amount of carbon lost as isoprene emissions can be significant in terms of the net ecosystem productivity (NEP) or net biome productivity (NBP), respectively. In estimating NEP and NBP, it may be important to evaluate the carbon sequestration with BVOCs including isoprene.

To estimate isoprene fluxes between the ecosystem and the atmosphere accurately, we conducted the isoprene flux measurements between 2008 and 2009 in *Quercus serrata* (Japanese oak) forest; one of the major tree species in Japan. The mean daytime flux was the highest on August 22, 2008 of 3.1 ± 1.2 mgC m^{-2} h^{-1}. The seasonal variations of daytime isoprene fluxes have a strong relationship with the daytime air temperature. At the time when the leaves have turned into yellow, no isoprene flux and no concentration of isoprene in the air were observed. We considered that there is a strong relationship between photonic synthesis and isoprene synthesis, so that, when photonic synthesis stops with chlorophyll degradation in the end of November, isoprene synthesis also stops and isoprene emission didn't occur. Besides, in order to estimate the ratio of the carbon re-emitted by isoprene in Japanese oak forest, the observed isoprene fluxes were compared with the observed CO_2 fluxes. The data for the 4 days from Aug. 22 to Sep. 28 in 2008 were used and the ratio was calculated to 1.2 % in total. The highest ratio was 2.3 % observed on Aug. 22 in 2008 when the air temperature was the highest and the soil was most desiccated due to the no rain fall before the two weeks. We considered that the ratio would be the highest in the hottest and the most dried season, which is the middle of August.

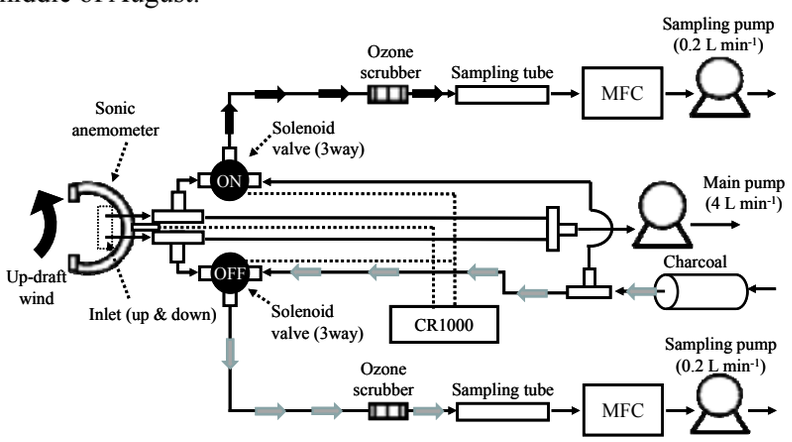

Fig.1 A schematic figure of the developed REA sampling system and the air flow of sampling. Isoprene free air was produced by flowing ambient air through the charcoal.

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SEASONAL VARIATIONS OF CARBON DIOXIDE EXCHANGE AT A TRELLIS TRAINING JAPANESE PEAR ORCHARD

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Recently, it is important to clarify CO_2 exchange at farm lands including fruit orchards. But the example of analyzing the CO_2 exchange for long-term in a fruit orchard is few. Japanese pear [*Pyrus pyrifolia* (Burm. f.) Nakai] is one of the popular deciduous fruit tree and planted through Japan. Japanese pear is cultured with trellis training and this technique is characteristic because thin canopy layer stretches over ground. Another doesn't have this feature. Therefore, we measured CO_2 exchange in a Japanese pear orchard for a year.

Measurements were conducted at the Japanese pear orchard, 340m length and 200m width, in Shimotsuma, Ibaraki, Japan (36º 12'N, 139º 56'E). In the orchard, Some Japanese pear cultivars with diffrent ages were planted. Net ecosystem exchange (NEE) in the whole orchard ecosystem was measured by the eddy covariance method. Wind velocity and virtual temperature fluctuations were measured with a three-dimensional sonic anemometer (R3, GILL INSTRUMENTS LTD). Fluctuations in CO_2 concentration were measured with an open-path gas analyzer (LI-7500, LI-COR). Vertical flux densities were evaluated every half hour by computing the covariance of CO_2 and temperature fluctuations with the fluctuating vertical velocity. The double rotation was applied for each averaging period. High-frequency losses due to sensor separation and inherent time lag between instruments were corrected using the band-pass technique. The water vapor effect on virtual temperature (Schotanus, 1983) and the density effect (Webb et al., 1980) on humidity were also corrected. Detrending is not used to avoid unexpected low-frequency losses. The quality control procedure proposed by Vickers and Mahrt (1997) was applied to the raw time series data. Solar radiation (*Sr*) and air temperature (*T*) was measured by the pyranometer (MR-40, EIKO) and the ventilated thermometer (HMP-45, VAISALA) above the Japanese pear canopy every 5 s and recorded in the data logger (CR5000, Campbell Scientific) every 30 min. Leaf area index (LAI) was measured with the plant canopy analyzer (LAI-2000, LI-COR) about every 2 weeks.

In winter, NEE was positive value. Although after leafing, NEE changed negative value and decreased gradually until middle June. After that, NEE became almost constantly. From October, NEE increased gradually and changed positive value again around leaf fall period. Our results suggest that seasonal variations of CO_2 exchange in the Japanese pear orchard were mainly affected with seasonal change of LAI.

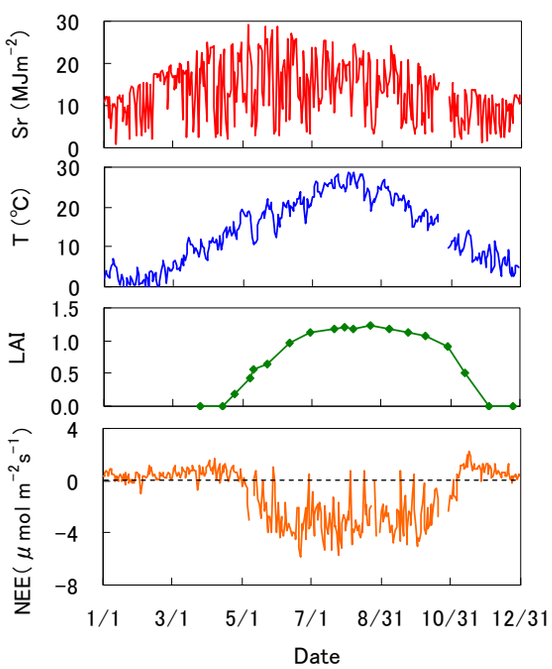

Fig. 1 Seasonal variation of *Sr*, *T*, LAI and NEE

Poster II

Poster II

P248

CHARACTERISTICS OF CO_2 CONCENTRATION CHANGE AT WARM TEMPERATE FOREST SITUATED IN COMPLEX TERRAIN.

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[2] Faculty of Agriculture, Kyoto University, Japan,
[3] Graduate School of Agricultural Science, Kobe University

1. Introduction

Net ecosystem exchange (NEE) of various forests around the world have mainly been conducted using micrometeorological methods. Combinations of eddy-covariance methods and changes in CO_2 storage have also been commonly adopted. However, because the eddy-covariance method requires adequate mixing of the air and measuring changes in CO_2 storage requires conditions under which horizontal advection can be ignored, the use of eddy fluxes may underreport nocturnal respiration during periods with low wind speed. U* filtering have been adopted for estimation of nocturnal respiration on such conditions, however, direct measurement or estimation method of nocturnal respiration rate have been required. In this study, we built two small metrological towers at valley in a forest situated on complex terrain. And measured CO_2 concentration changes, wind velocity, air temperature change continuously. And we attempted to educe characteristics of CO2 storage change at a forest situated on complex terrain.

2.Site and method

The study was conducted in the Yamashiro Experimental Forest (temperate secondary broad-leaved forest in central Japan, 34°47'N, 135°50'E). Quercus serrata is a dominant species in the site. Annual mean air temperature was 15.5 °C and annual precipitation was 1449 mm in 2002. Tower CO_2 flux has been measured from 2000. Two small metrological towers (height=10m) were constructed along valley. Horizontal distance between two towers is about 60m. CO_2 concentration at 3 heights (GMP-343; Visala), 3D wind speeds (model-81000; Young) and air temperature have been measured from Sep. 2008. More over spatial distribution of crown surface temperature was measured with thermograph (CPA-L50B; Chino) for measuring spatial variation of nighttime cooling process at forest crown.

3.Results and discussions

CO_2 concentrations at a height of 30cm on two towers were fairy synchronized in daytime and that of blow tower tended to be higher than above tower in nighttime. At both towers, nocturnal increase trends of CO_2 concentration were not like monotone functions, and even in midnight, decrease of CO_2 concentration frequently occurred and was related with decrease of air temperature that might caused by vertical advection.

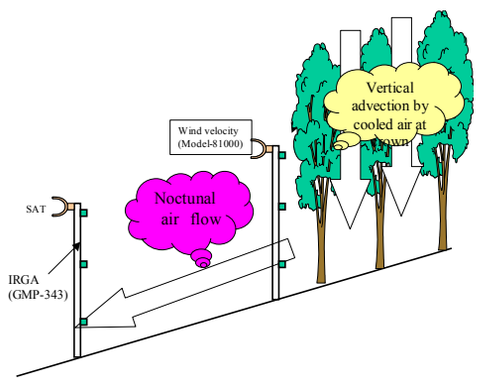

Fig.1 Method of measurement

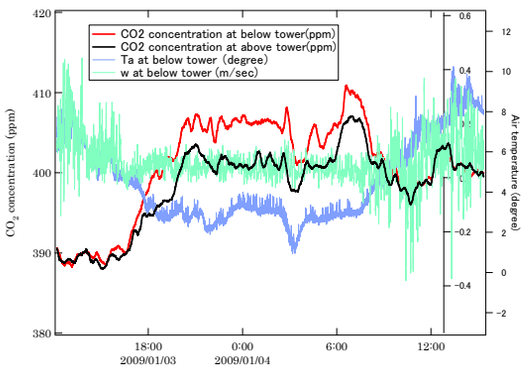

Fig.2 Change of CO_2 concentration at two towers

P249

LONG-TERM MEASUREMENTS OF THE CO_2 FLUX FROM LEAF LITTER USING AN AUTOMATED CHAMBER SYSTEM

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Introduction

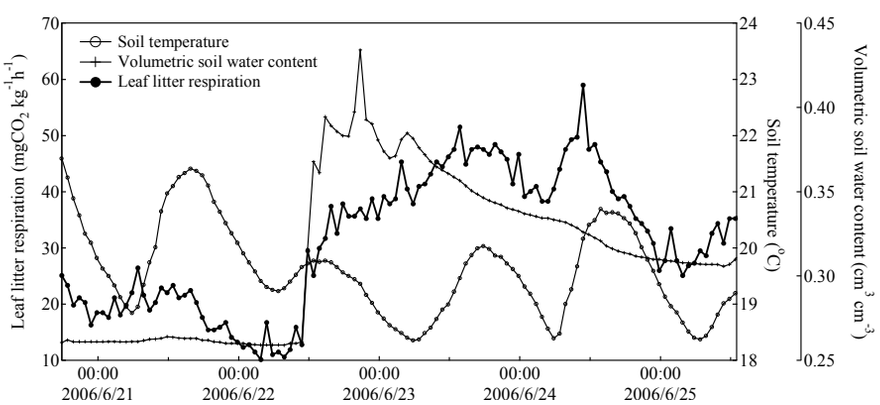
Several recent papers on forest carbon balance indicate that net ecosystem production (NEP) of forest ecosystem is a small difference between gross primary production (GPP) and ecosystem respiration (Re). Heterotrophic respiration (Rh) has a large estimation error for Re estimation that makes an uncertainty of NEP estimation. Carbon budget of decomposition processes of small and large organic matters and soil carbon accumulation are estimated from the amount of all litter input, soil respiration and root respiration estimation. However, temporal changes and spatial heterogeneity of each component should be taken into account for the estimations. In this study, we developed an automated respiration measurement chamber for leaf litter decomposition and examined the effect of environmental factors and decay level of leaf litter on a temporal change in leaf litter decomposition respiration.

Site and Methods

We measured leaf litter respiration using an automated measurement system in a secondary broad-leaved temperate forest in Japan (Yamashiro experimental forest, 34°47'N, 135°51'E). We carefully removed A_0 and A layer of the forest floor and seated an acrylic board between A and B layer to block soil respiration from B layer. We set an acrylic camber (40×20×20cm) on the board and filled inside and around the chamber with weathered granite soil to be equal to the depth of the surface of A layer. Inside the chamber, we inserted leaf litter (60g in air-dry weight). We assumed that this system could measure only leaf litter decomposition respiration because the acrylic board could block root and soil respiration. The chamber was electrically controlled to measure the respiration every an hour. When the lid of the chamber is open, rain can insert in the chamber as with environment of surroundings. The concentration of CO_2 in the chamber was measured by an infrared gas analyzer (LI-800, Licor Inc.). We also measured soil temperature and water content as environmental factors.

Results and Discussion

The automated respiration measurement system could measure continuously leaf litter decomposition respiration rate in the field (Fig. 1). Leaf litter decomposition respiration showed daily change following to soil temperature change with large hysteresis. The respiration also showed dramatically increase after rainfall event. One or two days after the event, the respiration showed a peak and decreased following with it's drying. These variations would reflect the mass and activity of microbes which decompose leaf litter. Leaf litter decomposition processes responded dynamically to environmental factors of forest floor. It would be a important information of these relationships for understanding R_h in forest ecosystems.



P250

SEASONAL ACCLIMATION OF ROOT RESPIRATION TO TEMPERATURE IN A BROAD-LEAVED FOREST IN JAPAN

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[2] Forestry and Forest Products Research Institute, Kyoto 612-0855, Japan

Introduction

Root respiration is estimated to account for 30-50% of total tree respiration and plays a key role in ecosystem level carbon cycling, which is a major source of soil CO_2 efflux. In addition, root respiration is critical for important physiological functions such as maintenance, growth, and nutrient uptake. Root respiration rate varies with fluctuations in temperature, because respiration is a temperature-sensitive enzymatic reaction.

Several studies have reported the temperature acclimation of root respiration in the laboratory and field. The respiration rate of very fine roots (< 0.5 mm in diameter) is higher than that of larger roots (Makita et al. 2009). However, less is known about the relationship between the temperature acclimation and root morphological traits of fine roots. The objective of this study was to document the seasonal acclimation of fine root respiration to temperature in relation to root diameter in mature trees.

Methods

This study was carried out at Yamashiro Experimental Forest, Kyoto, in a mountainous region of western Japan (34°47 N, 135°50 E). The forest consists of deciduous broad-leaved species (mainly *Quercus serrata*) and evergreen broad-leaved species (mainly *Ilex pedunculosa*). We excavated root segments (< 2 mm in diameter) of *Q. serrata* and *I. pedunculosa* every two months from August 2008 to June 2009 and measured the respiration rates of small fine root segments with a closed static chamber system immediately after sampling in the field. We examined the relationship between the respiration rates and morphological traits of the fine root segments, such as mean root diameter using WinRHIZO Pro 2007a (Regent Instruments, Quebec, Canada). To evaluate the effects of temperature on root respiration, we used an exponential function and calculated the values of $Q10$, which is an indicator of temperature sensitivity.

Results and Discussion

Root respiration rates in both species increased with increasing temperature (Fig. 1). The $Q10$ values for each root diameter class (0-0.5, 0.5-1.0, and 1.0-1.5 mm) were 2.4, 3.0, and 2.7 for *Q. serrata* and 1.9, 1.9, and 2.1 for *I. pedunculosa*, respectively. The values for both species were within the range of 2.0–3.0 reported in earlier studies (e.g. Atkin et al. 2000; Pregitzer et al. 2002). Moreover, there were differences in seasonal acclimation of root respiration to temperature between species. Seasonal change in Above- and below-ground growth of *Q. serrata* was larger than that of *I. Pedunculosa*. The differences in $Q10$ between two species may reflect variation in the root-respiratory acclimation to seasonal changes in the leaf and root growth pattern. The respiration rates of roots < 0.5 mm in diameter were higher and more variable than those of roots > 0.5 mm. In addition, with increasing temperature, the variation in respiration of smaller roots increased markedly. The high variation in the respiration rates of fine roots in this study may reflect variation in root age and life span, suggesting that, in addition to root diameter, root age and life span may affect seasonal acclimation of the root respiration to temperature.

References

Atkin, O.K et al. 2000. Response of root respiration to changes in temperature and its relevance to global warming. New Phytol. 147: 141–154.

Makita, N et al. 2009. Fine root morphological traits determine variation in root respiration of *Quercus serrata*. Tree Physiol. 29: 579-585.

Pregitzer, K.S et al. 2000. Research Review: Responses of Tree Fine Roots to Temperature. New Phytol. 147: 105-115.

P251

EVALUATION OF CO_2 FLUX FROM LEAF LITTER: EFFECTS OF FRAGMENTATION AND SPATIAL VARIATION IN EARLY DECOMPOSITION STAGE

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[3] Faculty of Agriculture, Nihon University, Japan
[4] Botanical Gardens, Faculty of Science, Osaka City University, Japan

1. Introduction

In quantification of carbon budget of forest, evaluation of heterotrophic processes (e.g. leaf litter, CWD, root litter) at forest is important. In Yamashiro Experimental Forest, we have tried to quantify CO_2 flux from various mediums. Decomposition respiration from leaf litter highly contributes to soil respiration . Moreover leaf litter respiration (R_{LL}) is highly affected by both environmental factors (e.g. temperature, water content of leaf litter) and media characteristics (e.g. size, spatial position, fraction), especially in warm humid conditions. Therefore, we examined relationship between leaf litter respiration, effect of leaf litter fragmentation and icrotoporogical conditions.

2.Site and method

Observations were performed at two sites situated in western Japan. **1.**Yamashiro Experimental Forest (YMS) located in the hilly mountains in southern Kyoto (34° 47' N, 135° 51'). Forest soil originated from weathered granite is very mobile and classified to be immature soil. **2.**Botanical Gardens Faculty of Science Osaka city University located in Osaka (34° 76' N, 135° 68'). We used leaf litter of *Quercus serrata* for respiration measurement. To examine the effect of leaf litter characteristics on the variation of R_{LL}, we set no fragmented and fragmented (about 1~3cm^2) leaf litter samples. To examine the effect of spatial variation of leaf litter on the variation of RLL, Set of litter (10 pieces) were piled up and fixed using wire pin on forest floor and 109 sets of samples (1090 pieces of leaf) was used for measurement. CO_2 Flux from leaf litter was measured using a small closed chamber (IRGA, VISALA GMP343). Each leaf of sample was measured separately (Fig.1). Water content was obtained from the difference between fresh weight and dry weight of the leaf litter sample. Temperature inside the chamber and soil temperature were concurrently measured using thermo-couples.

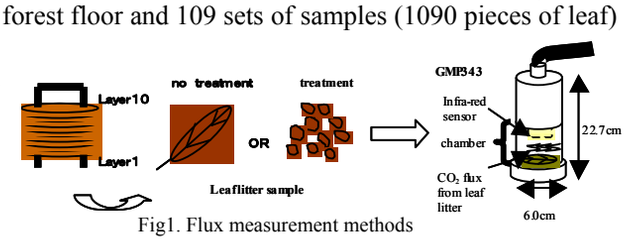

Fig1. Flux measurement methods

3.Results

Fig.2 shows differences of decomposition respiration rate between no fragmented and fragmented leaf litter at two sites. Mean R_{LL} of control leaf litter was from 10 to 30% larger than those of fragmented leaf litter. But, SD of each R_{LL} varied widely at both sites. Fig.3 shows clearly relationship R_{LL} and water content of leaf litter profile. Water content of layer1 (bottom of piled leaves, Fig.1) was about 3.2 times as larger as that of layer10 (top of piled leaves) . R_{LL} of layer1 was about 4.3 times as large as that of layer10. This result indicated that the different in water content of leaf litter among layers was one of the main factors that controlled the R_{LL} differences among layer. The effect of subtle spatial variation to leaf litter respiration might be larger than the effect of fragmentation.

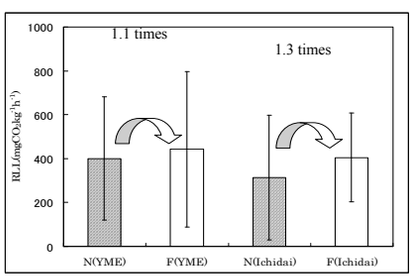

Fig2. Mean R_{LL} of no fragmented (N) and fragmented (F) leaf litter. The bars showed standard deviations.

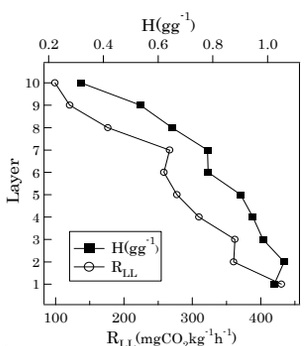

Fig3. Mean R_{LL} and H (water content of leaf litter) profile

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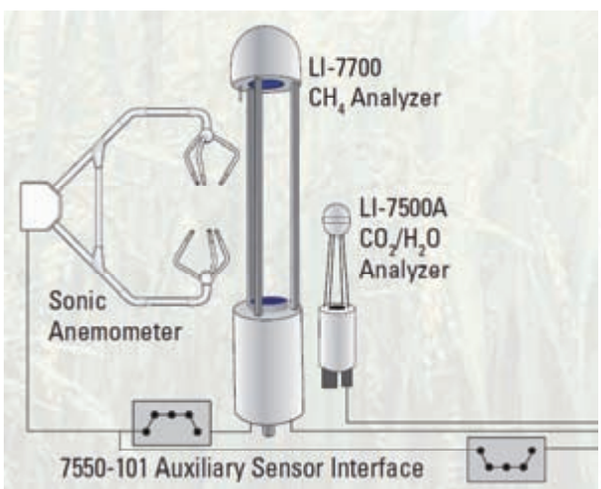

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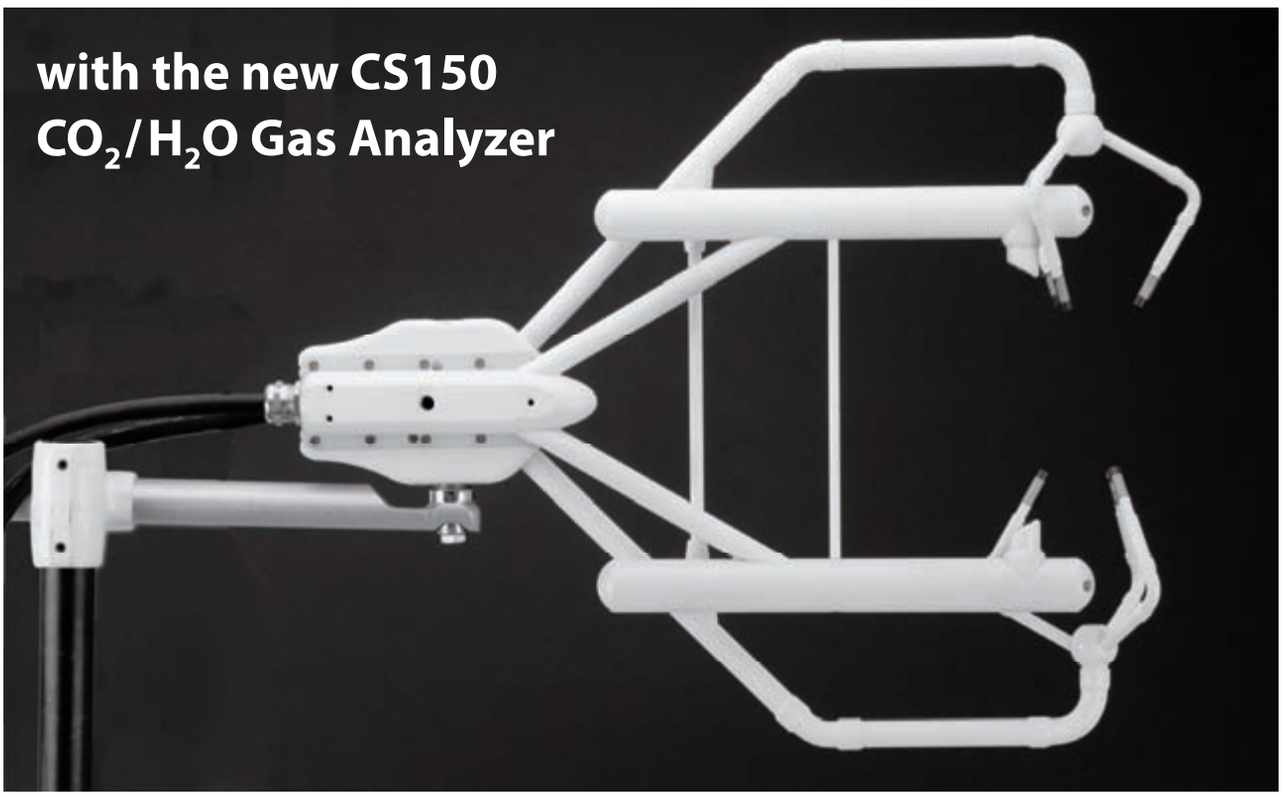

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Weight	0.75kg
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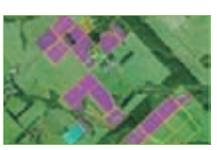

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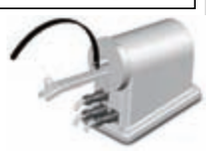
NEW MODEL

- Measurement and calculates direct, diffuse and global components of solar irradiance in each scanning



Open path CO_2/ H_2O Analyser

OP-2

- OP-2 has longer path length (80cm) to achieve higher resolution.

3D Ultrasonic Anemometer

USA-1

- USA-1 measures accurate wind and turbulence with solid-state 3D sensor.

High Precision Pyranometer

MS-802

- ISO Secondary Standard
- WRR traceable
- Accurate measurement of global solar radiation

Heat Flow Sensor

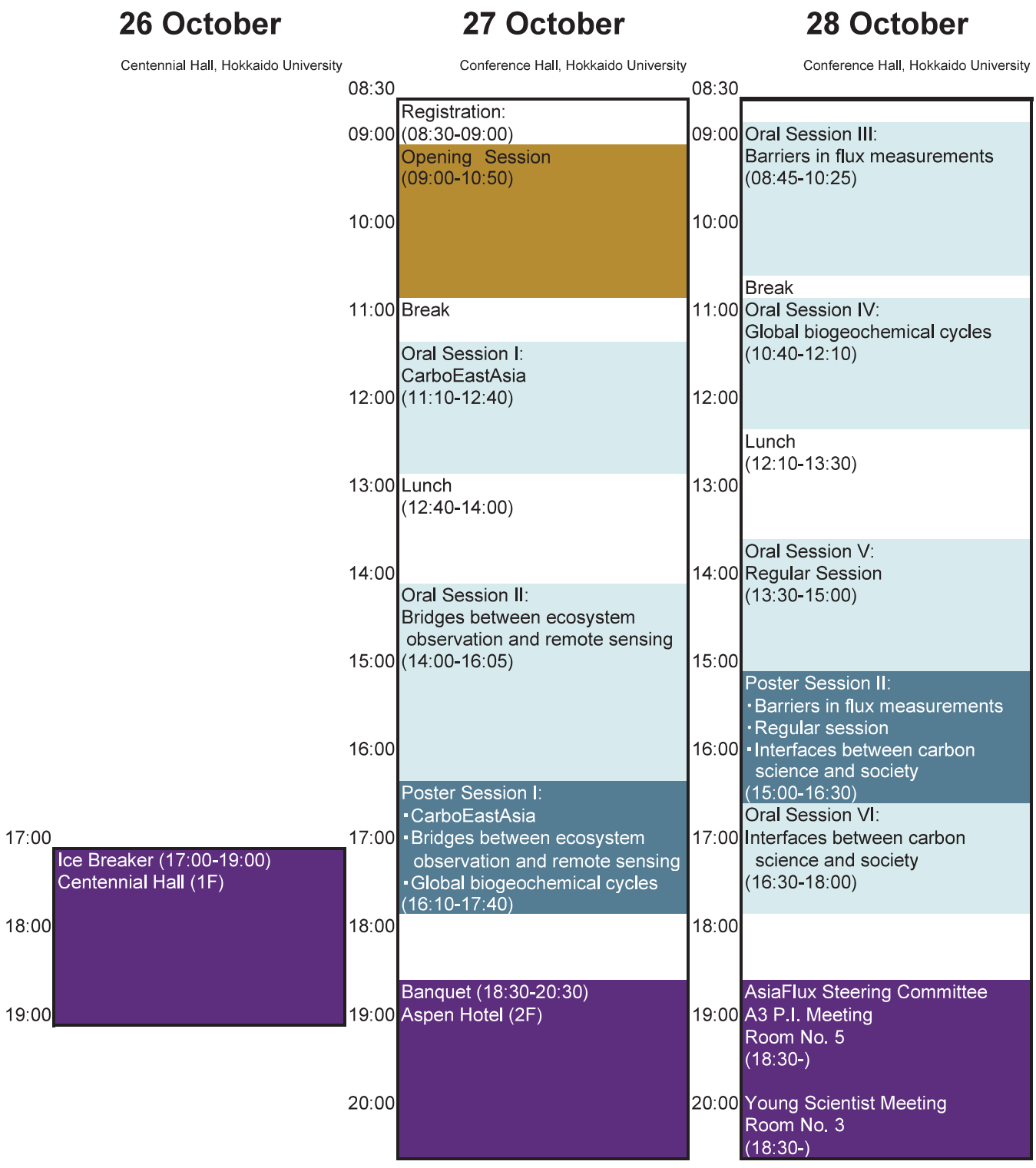
MF-180M

- Durable designed sensor
- Suitable sensor for the direct measurement of soil heat flux

EKO INSTRUMENTS CO., LTD.
1-6 Sasazuka Center Bldg., 2-chome Sasazuka,Shibuya-ku Tokyo 151-0073,Japan
PHONE: 81-3-5352-2913 FAX: 81-3-5352-2917
http://www.eko.co.jp E-mail: **info@eko.co.jp**

AD-061018E

Schedule



Ice Breaker: Centennial Hall (1F), Hokkaido University
Banquet: Sapporo Aspen Hotel (2F)
Reception, Poster Session, Business Displays: Entrance Hall, Conference Hall, Hokkaido University
Oral Sessions: Lecture Hall (1F), Conference Hall, Hokkaido University
AsiaFlux Steering Committee, A3 P.I. Meeting: Room No. 5 (1F), Conference Hall, Hokkaido University
Young Scientist Meeting: Room No. 3 (1F), Conference Hall, Hokkaido University