AsiaFlux training & seminar on methane flux and carbon cycle






23-27 February, 2014

Bangladesh Agricultural University, Mymensingh, Bangladesh

APN Asia-Pacific Network for Global Change Research

CHIBA UNIVERSITY

LI-COR® Biosciences

NIAES 30th Anniversary

National Institute for Environmental Studies, Japan

AsiaFlux training & seminar
on methane flux and carbon cycle

23-27 February, 2014
Faculty of Agriculture, Bangladesh Agricultural University,
Mymensingh, Bangladesh

Welcome to AsiaFlux Training & seminar!

In Asia, the number of tower flux sites which add methane flux measurement has been increasing since the open-path methane analyzer was commercially available. Users of the open-path methane analyzer, however, do not necessarily understand well how to keep the analyzer well-conditioned in the field and how to process the data in laboratory. AsiaFlux will have the training & seminar in Mymensigh, Bangladesh, where one of the AsiaFlux study sites is located and methane flux measurement has been recently started.

In the training course with sponsorship of LI-COR, we provide scientists, technicians and students engaged in tower-based flux studies, especially users of the open-path methane analyzer, with a three-day technical training course on eddy covariance gas flux measurement with special focus on methane flux measurement. In the seminar, we request participants to report their studies in respective sites, thereby encouraging them to publish journal papers and consequently promoting data integration in Asia. Methane flux has also been measured in rice paddy fields and wetlands in Asia since the 1980s by using chamber technique. Collaboration with scientists using chamber technique and data standardization will also be discussed in the seminar. We expect participants from South and Southeast Asian countries, but also welcome those from other countries in Asia.

Organizers:

- AsiaFlux
- Bangladesh Agricultural University, Mymensingh, Bangladesh

Local Organizing Committee:

- Md. A. Baten (Bangladesh Agricultural University, Mymensingh, Bangladesh)
- Akira Miyata (National Institute for Agro-Environmental Sciences (NIAES), Japan)
- Nobuko Saigusa (National Institute for Environmental Studies (NIES), Japan)
- Sawako Tanaka (National Institute for Environmental Studies (NIES), Japan)

Sponsors (in alphabetical order):

- APN (Asia-Pacific Network for Global Change Research)
- Graduate School of Horticulture, Chiba University, Japan
- LI-COR
- National Institute for Agro-Environmental Sciences (NIAES), Japan
- National Institute for Environmental Studies (NIES), Japan

Program of the AsiaFlux training
(23-25 February 2014; Bangladesh Agricultural University, Mymensingh, Bangladesh)

23 February, Sunday: LI-COR Training Course (Day 1)

09:00 – 09:15 Opening remark and self-introduction
09:15 – 10:45 Eddy covariance theory
(Eddy covariance theory, Example of long-term flux measurements)
10:45 – 11:00 Break
11:00 – 12:15 Eddy covariance applications and experimental design
(Eddy covariance applications, Concept of flux footprint and fetch requirement, Designing and implementation of eddy covariance experiment)
12:15 – 13:15 Lunch
13:15 – 14:15 Biomet (biological and meteorological) measurements and sensors
(The needs for Biomet data, Energy balance closure, Sensors and station)
14:15 – 15:15 Mymensingh flux site tour (15 minutes from the training room by walk)
15:15 – 15:30 Break
15:30 – 17:00 Operation theories of CO_2/H_2O and CH_4 analyzers and sonic anemometer
- LI-7500A and LI-7200 - LI-7700 - Sonic anemometer

24 February, Monday: LI-COR Training Course (Day 2)

09:00 – 10:00 Overview on setting up of LI-7500A, LI-7200 and LI-7700 eddy covariance systems
10:00 – 10:15 Break
10:15 – 12:00 Hands-on installations of eddy covariance systems
(Instruments layout, Wiring and system integration)
12:00 – 13:00 Lunch
13:00 – 15:00 Software, operation and maintenance of LI-7500A -7200 -7700 eddy covariance systems
(Software installation, operation, data collection, maintenance and troubleshooting)
15:00 – 15:15 Break
15:15 – 17:00 Calibrations of the LI-7500A/7200/7700

25 February, Tuesday: LI-COR Training Course (Day 3)

09:00 – 09:45 Data processing overview (Data processing principles, Data processing procedures including correction implementation, Software overview)
09:45 – 10:00 EddyPro and File Viewer software installations and sample data
(Software installation, Sample data preparation, File Viewer demonstration)
10:00 – 10:15 Break
10:15 – 11:00 Hands-on GHG data processing
11:00 – 12:00 Detailed explanations on EddyPro outputs
12:00 – 13:00 Lunch
13:00 – 14:15 Hands-on ASCII and TOB1 data processing
14:15 – 14:45 EddyPro advanced settings
14:45 – 15:00 Break
15:00 – 16:00 Data processing exercises with provided or your own data
16:00 – 17:00 Class discussion and summary (Comments and questions from the participants, Class evaluation by the participants, Class summary and certificate handing out)

Program of the AsiaFlux seminar on methane flux and carbon cycle
(26-27 February 2014; Bangladesh Agricultural University, Mymensingh, Bangladesh)

Wednesday, 26 February

Session I. Opening session		***Chair: Akira Miyata (NIAES, Japan)***
09:00-09:10	Opening address	*Md. A. Baten (BAU, Bangladesh)*
	Welcome address	*Lutful Hassan (Director of BAURES, BAU, Bangladesh)*
09-10-09:40	Keynote	*Joon Kim (SNU, Korea; presentation through Skype)*
09:40-10:15	Keynote	*Prabir Patra (JAMSTEC, Japan)*
Coffee/tea break		
Session II. Reports from LI7700 users		***Chair: Nobuko Saigusa (NIES, Japan)***
10:30-11:00		*Ma. Carmelita Alberto (IRRI, Philippines)*
11:00-11:30		*Md. Samiul Ahsan Talucder (SNU, Korea)*
11:30-12:00		*Keisuke Ono (NIAES, Japan)*
Group photos		
Lunch		
Session II *(cont'd)*		***Chair: Keisuke Ono (NIAES, Japan)***
13:00-13:30		*Suraj Reddy Rodda (ISRO, India)*
13:30-14:00		*Joseph Wenceslaus Waili (Tropical Peat Res. Lab. Unit, Malaysia)*
14:00-14:30		*Masayoshi Mano (Chiba Univ., Japan)*
14:30-15:00	Discussion	
Coffee/tea break		
Session III. Reports from other tower flux sites and chamber users		***Chair: Keisuke Ono***
15:15-15:45		*Md. Shahadat Hossen (BAU, Bangladesh)*
15:45-16:15		*Derrick Lai (The Chinese University of Hong Kong, China)*
16:15-16:45		*Chandra Shekhar Deshmukh (Nam Theun 2 Power Company, Lao)*
16:45-17:15		*Hoyt Alison (MIT, USA)*
17:15-17:30	Discussion	

Thursday, 27 February

Session III. *(cont'd)*		***Chair: Masayoshi Mano (Chiba Univ., Japan)***
09:00-09:30		*Md. Abdul Muyeed (BAU, Bangladesh)*
09:30-10:00		*Yongseok Kim (RDA NAAS, Korea)*
10:00-10:30		*Kazunori Minamikawa (NIAES, Japan)*
Coffee/tea break		
Session III. *(cont'd)*		***Chair: Masayoshi Mano***
10:45-11:15		*Md Badiuzzaman Khan (Ca Foscari Univ., Italy)*
11:15-11:45		*Hammad Gilani (ICIMOD, Nepal)*
11:45-12:15		*Wonsik Kim (NIAES, Japan)*
12:15-12:30	Discussion	
Lunch		
Campus tour		
13:30-15:30		Mymensingh flux site and other experimental facilities
Coffee/tea break		
Session IV. Wrap-up discussion		***Chair: Akira Miyata***
15:45-17:00	Discussion	
Closing remarks		*Md. A. Baten*

Abstract

What is the role of information in matter and energy exchange?

Joon Kim [1,2,3] and KoFlux contributors

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Understanding matter and energy exchange across the living earth's surface requires the consideration of information flow. Terrestrial ecosystems are open, self-organizing systems and energy of different quantity and quality provides the stimulus for organization, enabling different processes to progress at different rates. Information acts internally within the system to constrain its behavior, which can also flow into the system from outside, thereby prompting the direction of self-organization. The interplay of environmental conditions, matter, energy and information defines the context and constraints for the set of processes and structures that may emerge during self-organization. Theoretical background and the results of a case study are presented using the tower-based flux measurements of energy and matter at the vegetation-atmosphere interface. The goal of this presentation is to better understand the role of information in matter (e.g., CO_2 and H_2O) and energy exchanges.

Budgets of major greenhouse gases (CO_2, CH_4 and N_2O) from the South and Southeast Asia region

Prabir K. Patra, J. G. Canadell, and collaborators

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The South and Southeast regions are going through a transition from predominantly agriculture-based economies towards industrialised economy. This gives an opportunity to study various air pollutants for emissions (factors) from both natural and man-made activities, transformation through the air chemistry and transport out of the region. Understanding of these processes is key to enforcing or embracing the most efficient policies for local, regional and international air quality, weather and climate.

We have been working to assess the existing knowledge of GHG budgets under the Asia-Pacific Network (APN) project on Greenhouse gas budgets of South and Southeast Asia and the REgional Carbon Cycle Assessment and Processes (RECCAP). The effort is based on the synthesis and reconciliation of top-down (atmospheric observations and inverse models) and bottom-up estimates (ground-based flux observations and terrestrial models). While inverse estimates provide a regional net GHG balance, bottom-up estimates provide the necessary process attribution to shed light into future dynamics and the components of the balance that can be managed by human activity (Patra et al., 2013).

The needs for further bottom-up works were identified as (1) explicit representation of crops in terrestrial modeling, given the predominant role of agriculture in the region; (2) better constrains of emissions from wetlands, particularly for Southeast Asia, where extensive tropical peatlands exist; and (3) a region-wide effort on riverine carbon transport to coastal oceans (Patra et al., 2012). While the bottom-up studies are best conducted by the scientists well aware of the regional ecosystems, there is a large gap in monitoring of GHGs concentrations over major parts of Asia (http://ds.data.jma.go.jp; path: /gmd/wdcgg/cgi-bin/wdcgg/map_search.cgi).

Efforts are underway for measurement of GHGs in the South Asia in cooperation between national institutions in India or Bangladesh and foreign laboratories in Australia, France, Japan or USA. The foreign laboratories offers extensive experience in conducting high precision instrumentation that follows stringent requirement of absolute calibration in compliance with World Meteorological Organisation (WMO) standards, e.g., 0.1 ppm in 400 ppm of CO_2, 5 ppb in 1800 ppb of CH_4, 0.2 ppb in 325 ppb of N_2O. The necessity of establishing such high quality laboratories within each of the regions is becoming urgent, providing basic services to a wider community for top-down modelling, in addition to the ongoing collaborative activities.

Patra, P. K., J. G. Canadell, S. Lal, The Rapidly Changing Greenhouse Gas Budget of Asia, Meeting report, EOS Trans. AGU, 93, 237 19 June 2012.

Patra, P. K., J. G. Canadell, R. A. Houghton, S. L. Piao, N.-H. Oh, P. Ciais, K. R. Manjunath, A. Chhabra, T. Wang, T. Bhattacharya, P. Bousquet, J. Hartman, A. Ito, E. Mayorga, Y. Niwa, P. A. Raymond, V. V. S. S. Sarma and R. Lasco, The carbon budget of South Asia, Biogeosciences, 10, 513-527, 2013.

Measuring methane flux from irrigated rice fields by eddy covariance method using open-path gas analyzer

Ma. Carmelita R. Alberto [a,*], Reiner Wassmann [a,b], Roland J. Buresh [a], James R. Quilty [a], Teodoro Q. Correa, Jr. [a], Joseph M. Sandro [a] and Caesar Arloo R. Centeno [a]

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The newly developed LI7700 open-path methane analyzer was used to measure methane (CH_4) fluxes from irrigated rice fields using the eddy covariance (EC) technique. The diurnal and seasonal variations of CH_4 emissions over the whole cropping period of 2013 dry season (DS) were characterized. Clear diurnal cycles of CH_4 fluxes were observed during vegetative, reproductive, and ripening stages of the rice plant. Methane flux started to increase at around 0800H, reached a peak at around 1300H - 1500H, and then decreased to low values after 1900H. Peak CH_4 flux was 0.082 ± 0.048 μmol m^{-2} s^{-1} (1.31 ± 0.77 μg m^{-2} s^{-1}) during the vegetative stage (0 - 37 days after transplanting, DAT); 0.063 ± 0.021 μmol m^{-2} s^{-1} (1.01 ± 0.34 μg m^{-2} s^{-1}) during the reproductive stage (38 - 72 DAT); and 0.060 ± 0.033 μmol m^{-2} s^{-1} (0.96 ± 0.53 μg m^{-2} s^{-1}) during the ripening stage (73 - 103 DAT). The diurnal cycles were largely influenced by temperature (air, floodwater, and soil), surface energy flux, and net ecosystem CO_2 exchange. The seasonal variations in daily CH_4 emissions were primarily controlled by water management and the growth of the rice plants. This study has shown that intermittent irrigation during the vegetative stage was an effective water management strategy to lower the seasonal CH_4 emissions to about 3.26 g C m^{-2}. The irrigated rice field sequestered 306.45 g C m^{-2} of CO_2 from the atmosphere, released 3.03 g C m^{-2} of CH_4 to the atmosphere during the growing period, and yielded 5.44 Mg ha^{-1}. Considering a global warming potential (GWP) of 25 over a 100-year horizon, we accounted for the C footprint during the growing period: the irrigated rice field has taken up 1.88 kg CO_2 eq. per kg of grain produced. Additionally, the irrigated rice field had a net biome productivity of 17.22 g C m^{-2} and it is a C sink.

Report on CH_4 flux measurement in Gimje paddy site, Korea

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Seoul National University, Korea
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Rural Systems Engineering, Seoul National University, Korea
[3]*Korea Research Institute of Standards and Science, Korea*
[4]*National Academy of Agricultural Science, Korea*

We have been measuring CH_4 flux in a paddy flux site in Gimje, rice paddy-winter barley double cropping flat land in the southwestern coast of Korea, using the eddy covariance method since July 2011. Gimje is a typical rice producing site in Korea due to its suitable edaphic and climatic conditions. Generally, Paddy is transplanted on mid-June in puddling land and harvested 2nd week of October. There is first drainage in the last week of July. After two weeks, there is irrigation again. Then, repeating irrigation and drainage is started from last week of August until at the end of September. For CH_4 concentration measurement, the LI-7700 open-path laser spectrometer is used. This high-precision, low power, light weight, low maintenance sensor enables us to operate it on a continuous and long-term basis in an ecosystem scale. It has fully operator customized self-cleaning system only for lower mirror. Without frequent manual cleaning of the both mirror, the signal strength above the threshold level may not be maintained. Field is visited bi-weekly. Low signal strength of LI-7700 is caused significant data loss in normal condition. For raw data processing, EddyPro is used for applying necessary correction (e.g. high frequency loss and spectroscopic effect, etc.). Storage term is calculated and added to the final flux. Chamber technique is also used for methane flux measurement at this site.

Acknowledgment: This work was supported partly by the Korea Research Institute of Standards and Science under the Basic Project of 'Establishment of National Gas Analysis Measurement Standards and Improvements of Calibration/Measurement Capability' (Project no. 12011024 and no. 126010003) and partly through the National Agenda Project of 'Development of Measurement Technology for Solving Climate Change' funded by the Korea Research Council of Science and Technology (NAP-08-2).

Cross-validation of Open- and Closed-path Eddy-covariance Techniques for Observing Methane Fluxes

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Ayaka Sakabe[2], Kenshi Takahashi[4], and Akira Miyata[1]

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Methane (CH_4) is an important greenhouse gas, with a global warming potential per unit mass that is 25 times greater than that of carbon dioxide (CO_2) on a 100-year time scale. When applying the eddy-covariance technique for observing CH_4 exchange, there are currently two options regarding the type of gas analyzer: an open-path or a closed-path gas analyzer. Both analyzers have advantages and disadvantages and still have issues that need to be carefully examined for accurate flux calculations. Because the available open-path CH_4 analyzer, specifically LI-7700 from Li-Cor Inc., has a larger physical path length compared to open-path CO_2/H_2O gas analyzers, the expected larger high-frequency loss must be appropriately corrected. However, comparative studies using both analyzers are still limited in number. Important factors that affect the accuracy of fluxes may vary between sites, and comparative studies under different climates and in different eddy-covariance set-ups will provide valuable information. Therefore, we observed CH_4 fluxes with the eddy-covariance technique using both analyzers in a rice paddy field and evaluated the measurement values with an emphasis on the flux correction methodology. A comparison of the fluxes obtained by the analyzers revealed that both the open-path and closed-path techniques were reliable, provided that appropriate corrections were applied. For the open-path approach, the influence of fluctuations in air density and the line shape variation in laser absorption spectroscopy (hereafter, spectroscopic effect) was significant, and the relative importance of these corrections would increase when observing small CH_4 fluxes. A new procedure proposed by Li-Cor Inc. enabled us to accurately adjust for these effects. The high-frequency loss of the open-path CH_4 analyzer was relatively large (11% of the uncorrected covariance) at an observation height of 2.5 m above the canopy owing to its longer physical path length, and this correction should be carefully applied before correcting for the influence of fluctuations in air density and the spectroscopic effect. Uncorrected CH_4 fluxes observed with the closed-path analyzer were substantially underestimated (37%) due to high-frequency loss because an undersized pump was used in the observation. Both the bandpass and transfer function approaches successfully corrected this flux loss. Careful determination of the bandpass frequency range or the transfer function and the cospectral model is required for the accurate calculation of CH_4 fluxes with the closed-path technique.

Seasonal Variations of Methane Flux in Sundarban Mangroves, India

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Accurate and long term methane flux estimates from mangrove ecosystems are important to understand the role of mangroves as source of methane to the atmosphere. The Indian sub-continent has considerably good number of mangrove ecosystems which are reported to significantly contribute to methane emissions as per different studies carried out so far. However these studies are limited to short term point measurements and were not focused on continuous long term measurements to quantify methane fluxes and their seasonal variability. In order to understand the source strengths of methane emissions from mangroves, an eddy covariance flux tower was established in Sundarban Biosphere Reserve (SBR), India. Sundarbans is the biggest mangrove system in the world covering an area of 9000 km^2 of which 34% is in Indian territory and 66% in Bangladesh. Continuous measurements of methane are carried out using an open path IRGA (LI-COR LI 7700) at a frequency of 10Hz from April 2012 till date. In the present study, we report seasonal variability of methane fluxes from SBR for one annual cycle (April 2012 - Mar 2013). Results show that the study area is a net source of methane with a high degree of variability. As per preliminary analysis, daily average flux of methane was estimated to be at the rate of 150.22 ± 248.87 mg m^{-2} day^{-1} during April - May 2012. The relationships of methane efflux are also studied in relation to tidal activity and frictional velocity and are reported.

The study is carried out as part of the National Carbon Project, an Indian Space Research Organisation's (ISRO) initiative and is funded by ISRO's Geosphere Biosphere Programme (ISRO-GBP).

Relationship between eddy covariance methane and environmental factors in tropical peatland of Sarawak, Malaysia

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Tropical peatland is one of the important components in the global carbon because they represent a long-term sink of atmospheric greenhouse gases (GHGs). In addition, Southeast Asia contains the largest area of tropical peatland, covering 24.8 million hectares (56%) of total tropical peatland. Tropical peatland possesses characteristics which actively promote methane (CH_4) emission such high watertable. Global research communities are well apprised that CH_4 is one of the important greenhouse gases (GHGs), with a global warming potential approximately 20 times greater than carbon dioxide. Thus, evaluation on factors affecting CH_4 flux is essential if effective environmental management are to be implemented.

To date, only a few short-term studies on CH_4 emission based on closed chamber method had been conducted on tropical peatland. To our knowledge, there is no study reporting on a continuous CH_4 measurement from tropical region. Therefore, the main objective is to investigate the relationship between the magnitude of atmospheric CH_4 flux and some of the environmental factors that were monitored over a continuous timeframe. Further assessment was done on how the flux would be affected by environmental variables such as water table, soil temperature and solar radiation. Previous studies have reported that they could significantly bring some regulative impacts on the oxidation and emission of CH_4 in tropical peatlands and hence influencing global climate change. The delineation of the relationship between CH_4 flux and environmental factors would enable us to provide accurate and reliable information of CH_4 flux in tropical peatlands for the quantification of future climate change.

CH_4 Flux measurement by open-path eddy covariance system at rice field in Bangladesh

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Introduction

With respect to CH_4 emission from rice field, Bangladesh is the third largest CH_4 emission country in the world (Yan et al., 2007). However, it has an uncertainty because the estimate of Yan et al. (2007) for Bangladesh is based on the inventory data, not the in situ flux measurement. As far as I know the very few papers reported CH_4 flux from rice field in Bangladesh using chamber techniques (e.g., Frei et al., 2007; Ali et al., 2012) and no papers reported it using micrometeorological techniques. So it is essential to measure CH_4 flux continuously using micrometeorological techniques such as an eddy covariance method to quantify more reliable estimate and investigate controlling factors of CH_4 emission from rice field in Bangladesh. We, therefore, started the first CH_4 flux measurement by open-path eddy covariance system at rice field in Bangladesh, and will present some preliminary results in this abstract.

Site and Methods

The study has been conducted at the rice field of Bangladesh Agricultural University farm at Mymensingh, Bangladesh (24º 43' 31.0" N, 90º 25' 27.3" E, 18 m a.s.l.). At the study field, rice is cultivated two times in a year: the first one is named Boro (post-monsoon rice) from January to May, and the second one is named Aman (monsoon rice) from August to December.

An open-path CH_4 gas analyzer (Li-Cor, LI-7700) was installed to the ongoing eddy covariance system consisted of a sonic anemometer (Gill, R3) and a CO_2/H_2O gas analyzer (Li-Cor, LI-7500) on August 12, 2013. The data from the sonic anemometer and gas analyzers were collected by the LI-7550 (Li-Cor) at 10 Hz intervals. 30-minutes averaged CH_4 fluxes were calculated using EddyPro software (ver. 5.1.0) applying the general methodology of corrections. For quality control (QC), the policy of Mauder and Foken (2004) (the rank "0" is high quality, "1" is acceptable for budget analysis, and "2" should be discarded) was selected.

Results and Discussions

The data analyzed here was collected from August 12, 2013 to January 24, 2014, which produced 7968 runs in total (48 runs day^{-1} * 166 days). In the total runs, 20% of the runs were not calculated due to the malfunction or other reasons, and 35%, 28% and 16% of the runs were assigned to "0", "1" and "2" of the QC rank. Fig. 1 shows the CH_4 fluxes with the QC rank of "0" (closed circle) and "1" (open circle). From early November to late January, the runs with the QC rank of "1" increased and the CH_4 fluxes were close to zero. This phenomenon requires

further investigation, especially with respect to quali-ty check of the collected 10 Hz data.

Significantly high CH_4 fluxes (> 1.0 μ mol m^{-2} s^{-1}) were observed the time of transplant-ing in August, then it decreased to ca. 0.25 μ mol m^{-2} s^{-1} in late September, and kept it until November though when rice was growing up. This seasonal pattern was probably controlled by air/soil temperatures, and distinctly different from that observed in the rice field at Tsukuba, in Japan, where CH_4 flux changed approximately in conjunction with rice growth and its maximum was ca. 0.5 μ mol m^{-2} s^{-1}. Further continuous measurement would clari-fy how the CH_4 flux is controlled and provide the more reliable estimate of CH_4 emission.

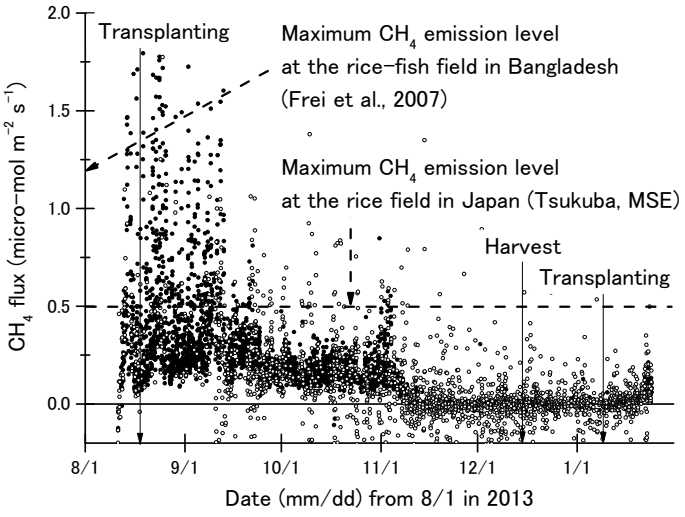

Fig. 1 Seasonal pattern of the 30-min. averaged CH_4 fluxes.

Seasonal variation of Carbon and energy fluxes over rice paddy field of Bangladesh

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Carbon dioxide (CO_2) flux was measured using the eddy covariance technique over rice paddy field at Mymensingh flux study site (24° 43' 31.0"N, 90° 25' 27.3"E; 18 m above sea level) from January 2011 to August 2012, and compared with 5-years average from 2006 to 2010. Gross primary production (GPP), ecosystem respiration (Re) and net ecosystem exchange (NEE) in the experimental period displayed distinct seasonal variations influenced by rice growth, and those seasonal variations generally followed averaged patterns in the previous years with short-term deviations from the averages caused by meteorological conditions. The seasonal variation of GPP showed its peaks of about 12 g C m^{-2} d^{-1} at full vegetative stage of Boro and Aman rice. Re also showed a seasonal variation, but its peaks was smaller (5-6 g C m^{-2} d^{-1}) and broader than those in GPP. NEE also showed a seasonal variation with peaks of assimilation (6 g C m^{-2} d^{-1}) at full vegetative growth stage. Active CO_2 exchange was also observed during the fallow period in rainy season, while the dry fallow period in winter was rather dormant in CO_2 exchange. In the experimental period, the most noticeable deviation from the averaged trend was an advanced trend of NEE in the 2012 Boro season influenced by the earlier transplanting of rice. Another deviation of GPP and NEE from the average observed in late growing season of the 2011 Boro rice was caused by early harvest. Differences in cropping periods not only resulted in deviations of seasonal trend from the average but also influenced seasonal and annual CO_2 budget of the paddy field. The Re/GPP ratio was generally stable, but interannual variability of CO_2 budget in the fallow period in rainy season had non-negligible impact on the annual Re/GPP ratio. Management practices thus affected not only seasonal variation of CO_2 flux but also its annual budget.

Biosphere-atmosphere Exchange of Greenhouse Gases in a Subtropical Mangrove in Hong Kong

Derrick Y.F. Lai

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Mangroves are one of the most carbon-rich forests in the tropics as well as one of most productive ecosystems of the world. While mangroves are generally long-term sinks of atmospheric CO_2, they are also potentially a large source of CH_4 which is a very potent greenhouse gas over the short term. Thus, quantifying both the net CO_2 uptake and CH_4 emissions is essential for determining the overall contribution of mangrove ecosystems to atmospheric radiative forcing and climate change. The micrometeorological technique has numerous advantages over the biomass inventory and chamber approaches in estimating the net ecosystem exchange of greenhouse gases, but it has rarely been employed in mangrove wetlands compared to other ecosystems.

Given the paucity of research on the overall biosphere-atmosphere exchange of greenhouse gases in mangrove ecosystems, this study intends to use a micrometeorological approach to: (a) quantify the annual net exchange of CO_2 and CH_4 from a subtropical mangrove wetland in Hong Kong; (b) investigate the temporal variability of mangrove CO_2 and CH_4 fluxes at the diel, seasonal and inter-annual time scales; and (c) examine the influence of environmental parameters on the temporal variations of CO_2 and CH_4 exchange between the atmosphere and the mangrove ecosystem. An eddy covariance system consisting of a sonic anemometer and fast response gas analyzers will be set up in the Mai Po mangrove forest to measure the net ecosystem exchange of CO_2 and CH_4 quasi-continuously and non-invasively for three years. In addition, ancillary measurements of various environmental parameters will be made to assist in the interpretation of flux data.

The results obtained in this proposed study will shed light on the role of subtropical mangroves in mitigating climate change, and provide baseline data for assessing the impacts of mangrove degradation and restoration on contemporary CO_2 and CH_4 fluxes. Moreover, the relationships established between gas fluxes and their environmental controls can be used to optimize management practices to minimize the adverse climatic impacts of mangroves, as well as parameterize biogeochemical models of mangroves to predict the effects of perturbations on greenhouse gas fluxes. Furthermore, the long-term flux data set generated can be used for collaborative regional and global synthesis of ecosystem carbon exchange.

The author has experience in using automatic chambers to measure trace gas exchange in wetland ecosystems, and in working on some eddy covariance flux data provided by other investigators. However, he has no prior first-hand experience in setting up a tower and working on the raw data collected by an eddy covariance system. The workshop will help him in establishing the knowledge and skills required in succeeding in this research.

Physical controls on methane (CH_4) emissions from a newly flooded subtropical freshwater hydroelectric reservoir: Nam Theun 2

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In the present study, we measured CH_4 ebullition and diffusion with funnels and floating chambers in the footprint of an eddy-covariance system measuring CH_4 emissions at high frequency (30 min) in the Nam Theun 2 Reservoir, a recently impounded (in 2008) subtropical hydroelectric reservoir located in Lao PDR, southeast Asia. The EC fluxes were very consistent with the sum of the two terms measured independently (diffusive fluxes + ebullition = EC fluxes), indicating that the EC system picked-up both diffusive fluxes and ebullition from the reservoir. The EC system permitted to evidence a diurnal bimodal pattern of CH_4 emissions anti-correlated with atmospheric pressure. During daytime, a large atmospheric pressure drop triggers CH_4 ebullition (up to 100 $mmol.m^{-2}.d^{-1}$) whereas at night, a more moderate peak of CH_4 emission was recorded. As a consequence, fluxes during daytime were twice higher than during nighttime.

A total of 4811 measurements of CH_4 ebullition fluxes with funnels at a monthly frequency and covering the depth range from 1 to 16 m and all types of flooded ecosystems allowed to determine that ebullition depends mostly on water level change among many other variables tested. An artificial neural network model could explain up to 45% of variability of ebullition using total static pressure (sum of hydrostatic and atmospheric pressure), variations in the water level and atmospheric pressure, and bottom temperature as inputs. This model allowed extrapolation of CH_4 ebullition at the reservoir scale and performing gap-filling over four years. Our results clearly showed a very high seasonality: 50% of the yearly CH_4 ebullition occurs within four months of the warm dry season. Overall, ebullition contributed 70-80% of total emissions from the surface of the reservoir (disregarding downstream emissions) suggesting that ebullition is a major pathway in young hydroelectric reservoirs in the tropics.

Methane and CO_2 Emissions from Tropical Peat Swamp Forests

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Tropical peat swamp forests in Southeast Asia are a large carbon store but are being rapidly drained and deforested. This work explores CO_2 and CH_4 emissions from a tropical peat swamp forest in Brunei. Peat surface CO_2 emissions were measured with high frequency using an automated chamber system and were compared against the groundwater table depth and temperature. Water level in the peat was the strongest driver of peat surface CO_2 fluxes. CO_2 flux increased linearly with depth to water table, when the water table was below the peat surface. Under flooded conditions, CH_4 emissions are expected to dominate. We measured dissolved CH_4 concentrations in the peat porewater and found significant concentrations of 0.1-0.5 mmol/L. Measurements were made following a vertical profile from the peat surface to 4.5m below the surface. Concentrations increased with depth. In 2014 we plan to measure CH_4 emissions from the peat forest using the LI-7700, which has already been purchased by our research group. As a PhD student working in Southeast Asia, this workshop offers an opportunity for me to learn how to maintain the LI-7700 in the field and effectively process the data, contributing to a better understanding of CH_4 fluxes from peat swamp forests in the region.

Methane emission from Municipal Solid Wastes compost amended rice and maize field

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Methane (CH_4) emission as well as total CH_4 flux measures from the Municipal Solid Waste (MSW) composting unit, crop fields amended with MSW compost, and the MSW landfill were monitored using a glass chamber technique and CH_4 content was quantified using gas chromatography. Boro rice and Maize fields were amended with MSW compost @ 0 (control), 10 and 20 t ha^{-1} along with recommended fertilizer doses and CH_4 flux was monitored at different growth stages. CH_4 flux from the crop fields was maximum at noon and minimum at the onset and end of the day indicating that CH_4 flux has a positive correlation with solar radiation as well as soil temperature. CH_4 flux was very much dependent on the use MSW compost and maximum flux was recorded at 20 t ha^{-1} followed by 10 t ha^{-1}. CH_4 flux was more in reproductive stage (8.12 $mgm^{-2}h^{-1}$) compared to vegetative stage (1.90 $mgm^{-2}h^{-1}$) of rice. CH_4 flux from maize field was very scanty and it was about 10 times lower than that of rice field (wetland) indicating poor CH_4 emission from dry field (maize). CH_4 flux over the MSW landfill in Mymensingh gradually increased to a peak at about 13.00h (4.60 $mgm^{-2}h^{-1}$) and thereafter declined as was recorded from the crop fields. CH_4 flux from the MSW compost heap measured over the day without replacement of gas chamber and the cumulative flux after 8 h starting from chamber placement was as high as 91.13 $mgm^{-2}h^{-1}$. MSW compost heap and rice field amended with aerobically produced compost are the important sources of CH_4 emission.

Observation of CO_2 and CH_4 fluxes from a Rice Paddy Field in South Korea

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To observate CO_2 and CH_4 fluxes, a CO_2 flux tower and four CH_4 flux monitoring chamber systems were installed at a rice paddy field(35.744 °E and 126.852 °N) with rice-barley double cropping system in Gimje, South Korea. Rice were transplanted in three chambers with same plant density except for one chamber. A chamber without plants was initially installed to investigate CH_4 fluxes from bare soil. A small fan was installed to uniformly distribute CH_4 concentrations inside of the chambers and CH_4 concentrations were measured 8 times a day using a gas chromatography with a flame ionization detector. The fetch of the CO_2 flux towers is from 150 to 300 m. An infrared gas analyzer was used to monitor in-situ concentrations of CO_2 and H_2O in turbulent air structures. These concentration data in conjunction with sonic anemometer air turbulence data using a 3-dimensional sonic anemometer were used to determine fluxes of CO_2 and H_2O through the eddy covariance techniques.

As observation result, the total CH_4 emissions from the rice paddy field in 2012 were 118.1 kg C ha-1 and those in 2013 were 125 kg C ha-1. And the total daily observed NEEs during the rice growing seasons in 2012 were -2288.9 kg C ha-1 and those in 2013 were -3740.7 kg C ha-1. These results showed that rice paddy fields are a source of CO_2 and may contribute to reduce atmospheric CO_2 concentrations during rice growing seasons.

Standardization of a closed chamber method to measure CH_4 emission from a rice paddy

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An accurate measurement of CH_4 emission from a rice paddy is becoming increasingly important to implement carbon trading schemes, such as the Clean Development Mechanism (CDM) and the Bilateral Offset Credit Mechanism (BOCM). A closed chamber method has the merit of being easy to compare the effect of experimental factors on the CH_4 emission. However, the method has not always been consolidated among countries due to the limitations of scientific knowledge and instrument.

We are standardizing the measurement techniques as an activity of the Paddy Rice Research Group of the Global Research Alliance on Agricultural Greenhouse Gases. This activity is financially supported from the Ministry of Agriculture, Forestry and Fisheries of Japan as a 5-year international research project (MIRSA-2). Previous our works are (1) questionnaire survey for the measurement techniques in GRA participating countries, (2) identification of appropriate measurement frequency and the time of day based on understandings of rice physiology (Minamikawa et al, 2012), and (3) analysis and comparison of measurement protocols used in the countries. On the basis of the previous works and additional ones through the MIRSA-2 project, we are now developing measurement protocol for a closed chamber method that can be commonly used in every country.

In my presentation, I'm going to speak about the development process and a scientific basis to calculate hourly CH_4 flux from regular-interval gas sampling.

Reference

Minamikawa, K., Yagi, K., Tokida, T., Sander, B.J., Wassmann, R. (2012) Appropriate frequency and time of day to measure methane emissions from an irrigated rice paddy in Japan using the manual closed chamber method. Greenhouse Gas Measurement and Management 2: 118-128

Methane and carbon dioxide fluxes from peat soils and rice fields

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Abstract

An investigation was conducted to quantify the present fluxes of CH_4 and CO_2 from peat lands and rice soils and also to investigate the controls on gas production. Soil samples were collected from rice field at Mymensingh, Bangladesh and from peatsoils, Crowden, Peak District to characterize the samples and for ex-situ measurement. Water content was determined by drying to constant weight at 50 0C from both peatsoils and rice soils. To determine the organic compound present in rice soil, normal pyrolysis was done. Gasclam® was used to measure the gas concentration from both ex-situ and in-situ measurement. To quantify the greenhouse gas fluxes, ex-situ measurement was conducted to give gas production in per unit of soil (mole/tonne dry weight soil/day). An in-situ measurement was made for the validation of ex-situ data by measuring greenhouse flux using concentration ratio in-situ. The ex-situ measurements of greenhouse gas fluxes are reliable enough for uneroded peat as they are validated by comparison with concentration ratios of in-situ measurements greenhouse fluxes. The ex-situ measurements of greenhouse gas fluxes are not reliable enough for rice soil as they are invalidated by comparison with concentration ratios of in-situ measurements of greenhouse fluxes. There is no strong relationship between atmospheric pressure and patterns of greenhouse gas production in peat and rice soils. Gas concentrations are remarkably constant despite varying pressure. However, the gas production and atmospheric pressure showed fluctuation during the measurement period. There was not enough organic matter for detection organic analysis. However in future the organic matter can be extracted and analysed.

Key words: peat soil; rice soil; in-situ measurement; ex-situ measurement; organic analysis

Carbon stock estimation and mapping through geospatial data and techniques – Envisioning GHG emission and sequestration

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Nepal is now one of fourteen countries selected in the first batch by the World Bank within the FCPF for addressing global climate issues under the REDD principles. To support the Nepal's REDD activities, ICIMOD in collaboration with Federation of Community Forestry User's, Nepal (FECOFUN) and Asia Network for Sustainable Agriculture and Bioresources (ANSAB) is implementing "Design and setting up of a governance and payment system for Nepal's Community Forest Management under Reducing Emissions from Deforestation and Forest Degradation (REDD)" financed by the Norwegian Agency for Development Cooperation (NORAD) under the Climate and Forest Initiative, the project covers over 10,000 hectares of community-managed forests and has an outreach to over 16,000 households with over 89,000 forests-dependent people. It is one of the world's first carbon offset projects involving local communities in monitoring the carbon in their forests and providing the necessary training for them to do so. We are continuously monitoring the carbon stock through ground measurements and satellite data. But now we are interested to know about the GHG emission and sequestration. AsiaFlux training is one of the opportunity where I can get into knowledge about whole process and techniques to interpret the data.

FluxPro as a realtime monitoring and surveilling system for eddy covariance flux measurement

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Using the eddy covariance (EC) method, fluxes of energy, water and carbon dioxide over various vegetations have been globally measured to understand responses of terrestrial ecosystem under the global climate change. However, it is not only laborious to immediately address the flux (F) under the complexity of calculation process and quality control, but also troublesome to instantly maintain remote EC sites against instrumentation problems and administrative difficulties. To overcome the issues, namely to challenge a prompt monitoring and surveilling, FluxPro is created based on three functional systems: 1) Gathering system to transport raw data from the sites to FluxPro server by every one hour; 2) Cooking system to compute F with the data considering its uncertainty together with micrometeorological informations; and 3) Informing system to present the F with fruitful kinds of charts over various time scales in realtime base. FluxPro could be appropriate tool to automatically produce F and to continuously maintain EC sites.

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AsiaFlux (**www.asiaflux.org**) is the Asian arm of FLUXNET, the worldwide research network of flux monitoring towers for carbon, water and energy cycles in terrestrial ecosystems

Mission

To bring Asia's key ecosystems under observation to ensure quality and sustainability of life on earth.

Vision

1) develop forward-looking collaborative researches and data sets on carbon, water and energy cycles in key ecosystems in Asia;
2) provide workshops and training on current and future challenges proposed by global change; and
3) cultivate the next generation of scientists with skills and perspectives so that they are prepared to engage in regional sustainability challenges in Asia as informed leaders and stewards through ecosystem approach with resilience-based systems thinking and visioneering

92 sites are registered in Feb 2014