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AsiaFlux Newsletter

Contents

Report on "The Seventh International Carbon Dioxide Conference (ICDC7)"

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"The Seventh International Carbon Dioxide Conference" organized by National Ocean and Atmosphere Administration/Climate Monitoring and Diagnostic Laboratory (NOAA/CMDL) was held in Bloomfield, Colorado, USA on 25-30th of September, 2005, with over 400 participants from all over the world. This conference is one of a series of scientific conferences that have been held every four years, since its first meeting in 1981 in Bern, Switzerland. The last one was held in Sendai, Japan, and this was the first time in USA, Colorado, where many institutions such as NOAA/CMDL, National Center for Atmospheric Research (NCAR), University of Colorado (CU), Colorado State University (CSU) and others, are conducting intensive research on atmospheric CO_2. This conference was chaired by P. P. Tans of NOAA/CMDL.

A view of OMNI Interlocken Resort Hotel. Wild lives (rabbit, prairie dog, etc.) were seen around.

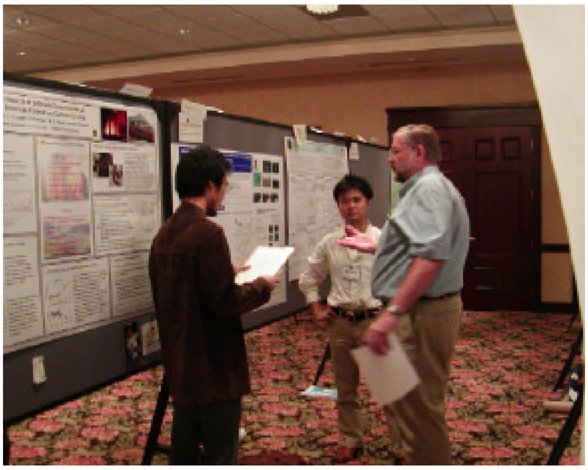
What struck us when we arrived at Denver international airport was the clear blue sky. Denver and surrounding cities are located at elevation of over 1600 m above sea level. People who are living there call their own city "Mile high city". Rumor (or could it be a true story?) has it that, in the laboratories there, even the air-samples collected under ambient pressure in low land need no pumping or suction for the introduction into measurement system because there exists enough pressure difference between the pressure of the sample airs from low land (~100kPa) and ambient pressure there (~84kPa). One more topic about "Mile high city" is that the liquor starts to affect people quickly, so we should not drink too much.

On the day before the sessions started, reception of the conference was held in a ballroom of the OMNI Interlocken Resort, the venue of this conference. We enjoyed having a lively conversation with associates and competitors from the world over tasty local beer of Colorado.

Main sessions of the conference started on 26th of September and went on for next 5 days. Presentations (oral and poster) were divided into 5 themes ("The fate of fossil fuel emissions", "Land use and the terrestrial carbon cycle", "Carbon cycle response to environmental change", "Effects of high CO_2 on land and ocean ecosystem" and "Managing the carbon cycle"). This has shown evidence that advanced carbon cycle study required interdisciplinary efforts and mutual understanding. Many oral presentations were made for introducing review of developments in understanding CO_2 and related carbon cycle from diverse scientific communities after the Sendai conference. Substantial efforts and data accumulation had made steady progress in handling a lot of CO_2 issues.

Now we would like to introduce some topics that impressed us in the oral sessions. John Miller (NOAA/CMDL, USA) reported in "the fate of fossil fuel emissions" session that the CO_2 sink in the northern hemisphere appeared to be decreasing since 1992 based on the secular trend of north-to-south gradient in atmospheric CO_2 observed by NOAA/CMDL Global Air Sampling Network. Their constant efforts to collect long-term data under strict quality control made this analysis possible. Phillipe Ciais, Laboratorie des Sciences du Climat et l'Environnement (LSCE), France, showed in "carbon cycle response to environmental change" session that there occurred anomalistic net CO_2 release from European terrestrial ecosystems in 2003 due to an unusual heat wave and drought. They carried out an integrated analysis on the event from many points of view. This topic showed how net CO_2 sink/source in terrestrial ecosystem was sensitive to changes in environmental factors. In "land use and the terrestrial carbon cycle" session, some of presentations took up the subject of forest fire. While there were some reports of studies on the eastern-Asian forests in domestic meetings, reports on forest fire in other regions were scarce. We again realized the importance of studying on forest fires in the world. The conference banquet was held after the excursion in the afternoon of 29th of September. Emily Takahashi played the piano in front of the participants. She is a daughter of C. D. Keeling, the pioneer of the atmospheric CO_2 studies as we all know. Dr. Keeling had passed away just before this conference. As she told us about her memory of her late father in the intersession of her piano performance, the ballroom was filled with sorrow. At that moment, we realized that we must succeed to the great pioneer's will.

In this conference, much time was shared for poster presentations which had promoted active discussions about various topics. Lively and useful discussions were made indeed in the rooms. From the CarboEurope group, several results of continuous multi-gas-species measurement using tall tower network called CHIOTTE were presented by A.C. Manning, The Max-Plank-Institute for Biogeochemistry (MPI-BGC), Germany, in "the fate of fossil fuel emissions" session. On the other hand, several groups introduced their results of CO_2 and stable isotopes by regular sampling using aircrafts (M.



A scene in the poster session. It was a good opportunity for young scientists to discuss their research with the leading authorities in each scientific field.

Ramonet, LSCE, France; P. Sturm, Univ. of Bern, Switzerland; C. Sirignano,Centrum voor Isotopen Onderzoek (CIO), Netherland, in the same session. Those strategies would have important meanings to coordinate surface CO_2 flux with atmospheric transport model. Those types of study were not popular in Asian region at present. However, if similar observation network was established in Asian countries, it would definitely contribute largely to the progress of understanding global carbon cycle. Additionally, we think that the utility values of observational data of trace gases other than CO_2 in carbon cycle study will be noted more carefully also in the Asian CO_2 research communities. The session of land use and the terrestrial carbon cycle had many presentations about soil carbon; carbon storage, soil respiration, root decomposition and so on. These studies suggested that soil carbon in the terrestrial ecosystem be very important. On the other hand, there were a few impressive presentations about tower flux measurements. R. Monson (CU, USA) and his group introduced the estimation of the error in measurements of net ecosystem CO_2 exchange using an array of seven towers distributed across a mountainous landscape. The flux measurement in the complex topography is known to be a big problem, similar to nocturnal underestimation in this study field. iLEAPS post-conference specialist workshop on "Flux Measurements in Difficult Conditions" will be held in Boulder, Colorado, near the venue for this conference. We hope that some helpful suggestions or ideas to solve this problem will be presented in the workshop.

In technical aspect, we were deeply impressed by the development of optical measurements of stable isotopes of atmospheric CO_2. S. Saleska (Univ. of Arizona, USA) presented that the performance of a laser-spectrometry based stable isotope measurement system would become good enough for net-isotope-flux measurements by eddy covariance (EC) method in near future. If on-site continuous high-precision measurements of stable isotopes of atmospheric CO_2 become a reality, many kinds of carbon cycle studies will enter a new phase.

An aircraft (C-130 Hercules) modified for exclusive use to atmospheric measurements in the hanger of NCAR-Research Aviation Facility. It belongs to National Science Foundation. There was a huge space inside for installation of various measurement systems. (A scene at the excursion to NCAR)

During our stay in Colorado, some participants had suffered from jet lag, but many exciting presentations kept us alert and it was really a fruitful week. We realized that the effort to spread Asian country's research activities over the CO_2 community was anticipated greatly because there were still existing extensive areas without reliable observational data or with unpublished good data related to CO_2 studies in Asia, even though many Asian countries have great interests in these studies. The next "CO_2 Olympic" will be held in Jena, Germany. We believe that many Asian colleagues will make greater contributions next time.

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iLEAPS:"The Integrated Land Ecosystem - Atmosphere Processes Study"the 10 year land-atmosphere core project of the International Geosphere-Biosphere Programme (IGBP)

Workshop on Observation of Carbon Cycle and Greenhouse Gases

Akira YAMAMOTO

National Institute for Environmental Studies, Japan

"Workshop on Observation of Carbon Cycle and Greenhouse Gases" was held in Tokyo from 10-11th of November, 2005. The organizers of this workshop are as follows:

- Workshop Organization Committee (Chair: INOUE Gen, consisted of 19 researchers)
- Climate Change Research Area (CCRA) of Global Warming Research Initiative under Council for Science kand Technology Policy (CSTP)
- Carbon Cycle Theme Group of Japanese National Commission for Integrated Global Observing Strategy (IGOS)

It was also co-organized by

- National Institute for Environmental Studies (NIES)

There were 142 participants for 32 invited oral presentations, which include two keynote speeches and 10 presentations for sessions on ocean, atmosphere, and terrestrial ecosystems, and 15 written presentations.

It is likely that this was the very first workshop in Japan on carbon cycle and greenhouse gases attended by such a long list of researchers from a broad range of research fields.

The presentation titles* and names of speakers in the keynote speeches and terrestrial ecosystems are as follows.

Keynote speeches (Chair: INOUE Gen. NIES)

- International program and domestic cooperation strategy for observation study on carbon cycle (INOUE Gen, NIES)
- Activity of Global Warming Research Initiative under CSTP (KOIKE Isao, The Univ. of Tokyo)

Terrestrial ecosystems (Chair: SAIGUSA Nobuko, AIST)

- Evaluation of the terrestrial ecosystems by integration of satellite observation and ecosystem modeling - Project for sustainable coexistence of human, nature, and the earth (YASUOKA Yoshifumi, The Univ. of Tokyo)
- Current state and challenges of AsiaFlux (OHTANI Yoshikazu, FFPRI)
- Integrated research on forest carbon budget at observation tower sites (SAIGUSA Nobuko, AIST)
- Current state and future prospect of measurement technique of soil respiration (LIANG Naishen, NIES)
- Potential of new satellites on earth observation and their measurements of terrestrial biomass (HONDA Yoshiaki, Chiba Univ.)
- The role of satellite observations of vegetation and PAR in modeling and monitoring of the terrestrial carbon cycle (Dennis DYE, FRCGC)
- Use of the observation data for the terrestrial carbon

cycle modeling (ITO Akihiko, FRCGC)
- Research on evaluation of the forest function as a carbon sink under the Kyoto Protocol (AMANO Masahiro, Waseda Univ.)
- Production and degradation process of evergreen broad-leaved tree community under warming environment by open top chamber methods (NAKANE Kaneyuki, Hiroshima Univ.)
- Effect of rising atmospheric CO_2 concentration on vegetation-soil ecosystems - information from Free-air CO_2 enrichment (KOBAYASHI Kazuhiko,The Univ. of Tokyo.)

*These English titles were translated from Japanese by the workshop secretariat (except the one presented by Dennis Dye).

The printed proceedings (in Japanese) will be published soon as CGER Report from Center for Global Environmental Research, NIES.

Atmospheric Boundary Layer (ABL) observations on the "Changwu Agro-Ecological Experimental Station" over the Loess Plateau, China

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1. Introduction

The Loess Plateau occupies a vast area of the middle part of the Yellow River Basin. From the meteorological point of view, the Loess Plateau is located near the border between "semi-arid" and "arid" regions with clear seasonal changes of the Asian monsoon system. Thus, surface and atmospheric boundary layer (ABL) conditions over this region will have important ramifications on the water cycle systems, not only within the Yellow River Basin, but also in all of the Eastern Asia. However, the seasonal and inter-annual variations of the surface and ABL conditions over this region have not been investigated thoroughly. The measurement of these conditions will greatly improve water cycle modeling by providing better data sets and updated model parameterizations.

The purpose of the ABL observations over the Loess Plateau is to diagnose the exchange processes of momentum, heat, water, and CO_2 in the land - vegetation - atmosphere system, and to re-construct the water cycle system over the Loess Plateau. In order to achieve this goal, we established an ABL observation system at the "Changwu Agro-Ecological Experimental Station, Chinese Academy of Science (CAS)" located in the southern part of the Loess Plateau, in the middle of May 2004.

The topography of the Loess Plateau includes not only tableland but also steep valleys. Over the tableland, the surface consists of various agricultural fields such as wheat, corn, and apples, in addition to houses and roads. Thus, in order to obtain regional surface fluxes, a tower with a height of only a few meters would be inadequate. Therefore a 30-m high tower was installed with 3 sets of turbulent sensors at three different heights to obtain regional surface fluxes as well as local surface fluxes of the surrounding agricultural fields. In addition, to measure the ABL development with sufficiently fine time resolution, a wind profiler radar (WPR) and a microwave radiometer were also installed. The unique target of these observations is to evaluate topographical effects on the surface layer turbulence and a mixed layer development over the tableland.

2. Installed Devices

The ABL observation systems at this station consist of
1) Wind Profiler Radar (WPR) manufactured by *Sumitomo Electric Industries*, Japan
2) Flux and Radiation Observation System (FROS) designed by *Climatec*, Japan
3) Microwave Radiometer (MR) manufactured by *Radiometrics*, USA.

These systems were installed at the meteorological field of the "Changwu Agro-Ecological Experimental Station" on Loess Plateau located at N35° 12’, E107° 40’. The site is classified as semi-arid region due to relatively low annual precipitation (584 mm), and the annual mean temperature is 9.1 °C.

The FROS measurement system produces the surface fluxes of momentum, sensible heat, latent heat (water vapor), and CO_2. For its operation, a 30-m high flux tower was placed at the center of the research field (Fig.1), on which 3 sets of ultra-sonic anemometer-thermometers and infrared H_2O/CO_2 gas analyzers were installed. A fine resolution (both in time and in spectral) radiation measurement system was also included as a part of FROS (Fig.2). The detailed locations of the sensors on this tower are shown in Table 1. The data obtained from this radiation system will be used for the calibration and detailed specification of local surface characteristics by means of optical satellite measurements.

The WPR system is designed to detect fluctuations of the refractive index in clear air. Its main objective is to measure vertical profiles of three dimensional wind velocities with high resolution in time and space. An important feature of WPR is that, besides the mean wind, it is also capable of measuring the turbulence. As a result, it has become increasingly popular for ABL research in the past decade (e.g., Angevine et al., 1994).

The principle of the WPR measurement can be summarized as follows. The WPR transmits UHF radio waves (1290 MHz), which are Bragg-scattered by refractive index irregularities at the scale of half the wavelength. Whenever there is wind flow, an apparent upward/downward shift in frequency is observed due to the Doppler effect. The WPR then receives these radio waves and detects the shift in the Doppler spectrum. From this shift, echo intensity, wind velocity and Doppler spectral width etc. are calculated.

3. Preliminary Results

<u>3.1. Surface parameters, fluxes, and turbulent spectra within the surface layer</u>

The surface roughness length Z_0 was estimated using wind and shear stress (momentum flux) data. The Z_0 value obtained at the 2-m height was around 0.1 (m) but values obtained at 12-m and at 32-m height were around

Fig. 1 The 30-m high tower installed on the field of "Changwu Agro-Ecological Experimental Station" over the Loess Plateau, China. The Wind Profiler Radar (WPR) is also shown.

Fig. 2 The radiation measurement system installed on the ground surface, as part of the FROS. An ultra-sonic anemometer-thermometer and an infrared H_2O/CO_2 gas analyzer are also shown.

Table 1 Installation height/depth of the sensors in FROS

Stage	Equipment	Height / Depth
32-m	Ultra-sonic anemo.-thermometer Infrared H_2O/CO_2 Gas Analyzer 3-Cup Anemometer Wind Direction Sensor HUMICAP (Vaisala) Infrared Thermometer	31.75 m 31.75 m 31.45 m 31.57 m 30.97 m 31.23 m
12-m	Ultra-sonic anemo.-thermometer Infrared H_2O/CO_2 Gas Analyzer 3-Cup Anemometer HUMICAP (Vaisala)	12.17 m 12.17 m 11.92 m 10.52 m
2-m	Ultra-sonic anemo.-thermometer Infrared H_2O/CO_2 Gas Analyzer 3-Cup Anemometer HUMICAP (Vaisala) Infrared Thermometer Barometer (Air Pressure Sensor)	1.86 m 1.86 m 1.65 m 1.90 m 2.35 m 2.00 m
Underground	Soil Heat Flux Plate (x 2) Soil Temperature (x 5) Soil Moisture Sensor (TDR) (x 6)	5, 5 cm 2, 10, 20, 40, 80 cm 2, 2, 10, 20, 40, 80 cm
Radiation	S↓, S↑, L↓, L↑, PAR↓, PAR↑ SpectroRadiometer Direct Solar Radiation	2.50 m 2.50 m 0.5 m
Precipitation	Tipping Bucket Rain Gauge	0.4 m

Table 2 Percentages of footprint results within different stability ranges

height	$\xi=(z-d)/L$			Z_0(m)
	$\xi <= -0.05$ unstable	$-0.05 < \xi < 0.05$ neutral	$\xi >= 0.05$ stable	
2m	49%	23%	28%	0.0948
12m	52%	11%	37%	0.5646
32m	55%	5%	40%	0.4655

0.5 (m) (Table 2). This means that the Z_0 at 2-m height represented local shear stress of the wheat field, while the Z_0 values at higher levels reflected more regional characteristics, including small trees.

The height differences were also obtained for the surface heat and CO_2 fluxes. The fluxes obtained at the lowest 2-m level were strongly represented by local wheat condition.

Footprint analyses based on Horst and Weil's study (1994) indicated that 70 % of the observed fluxes at 30-m height were contributed within 1 km under unstable and near neutral atmospheric conditions. Because the shortest distance from the flux tower to the edge of the valley is around 800 m, the turbulence of the lower part of the surface layer was within the internal boundary layer.

Although their peak magnitudes or amplitudes were different, the power spectra of the wind velocity (Figs.3 and 4) were similar to the previously obtained spectra of McNaughton (2004) and those of Hong et al. (2004). Thus the surface layer turbulence at the station appears to be similar to the turbulence reported in other studies.

3.2. ABL development

Diurnal changes in the ABL development were inspected using the WPR data. Whenever the surface was not so dry and surface sensible heat flux did not dominate, the ABL development was similar to the results reported in earlier studies. However, when the surface was quite dry and the buoyancy fluxes were large enough, a sudden rise of the ABL top was frequently observed. On those occasions strong upward and downward vertical wind velocities were observed (Fig.5) which penetrated the ABL top; this upper boundary was monitored using an algorithm of Angevine et al. (1994). Strong surface heating (large sensible heat fluxes) occurred when the ABL top was not strongly capped due to synoptic conditions (weak inversion).

Based on the synoptic weather chart, it seemed that such weak capping inversion was synchronous with the development of a "heat-low" system around the Loess Plateau. Thus, it is crucial to determine the main reason for such strong vertical wind motions over the region. Our hypotheses are that they are firstly due to topographical effects on the ABL development, and secondly due to weak capping inversion caused by the "heat-low" system over the Loess Plateau.

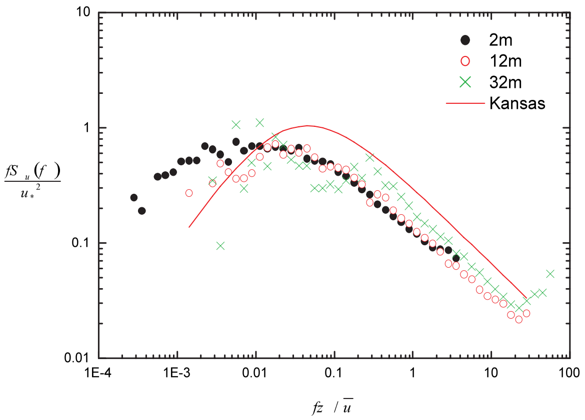

Fig. 3 Normalized power spectra of u wind velocity under near-neutral conditions estimated at three heights. A previously obtained result at the Kansas (Kaimal et al., 1972) was also shown.

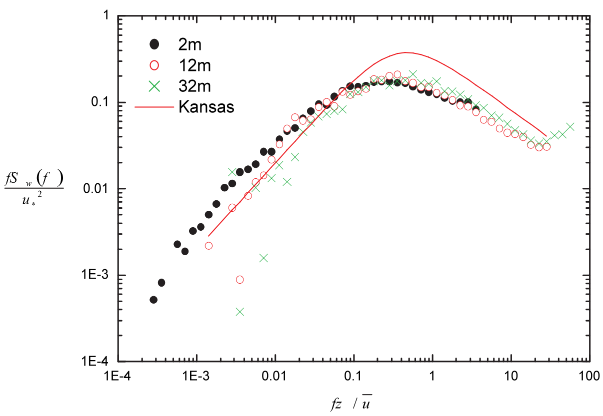

Fig. 4 Normalized power spectra of w wind velocity under near-neutral conditions estimated at three heights. A previously obtained result at the Kansas (Kaimal et al., 1972) was also shown.

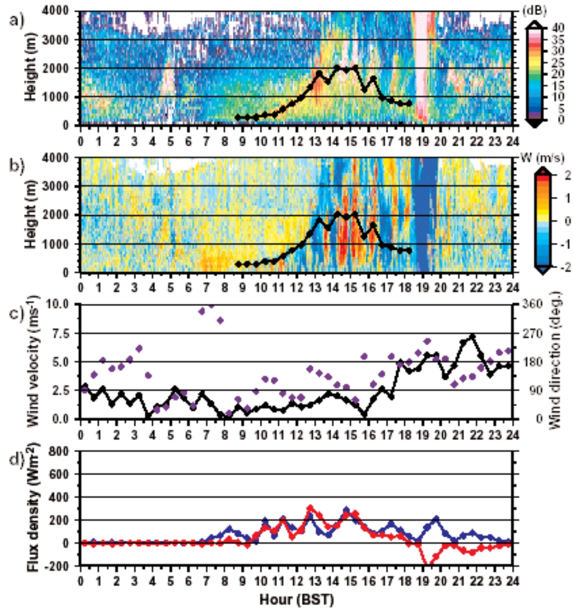

Fig. 5 An example of diurnal variation (19 June, 2005) in a) time-height section of echo intensity corrected with range, b) vertical wind speed, c) wind speed (line) and direction (dots) within the surface layer, and d) surface sensible (blue) and latent (red) heat fluxes at the station. The solid lines in the upper two figures indicate the upper boundary of the ABL, determined using the algorithm of Angevine et al. (1994).

4. Expected Results

Using the FROS data, we will be able to analyze and confirm various features of the turbulence in the ABL. For example, the "bottom-up model" or "Theodorsen ejection amplifier (TEA)-like structure" proposed by McNaughton (2004) will be verified using wind speed spectra calculated from turbulent data at different heights (Figs.3 and 4).

In a recent development, EOS MODIS has shown to have a high capability to measure the radiance of the surface with fine spectral resolution. Unfortunately however, most of current global products retrieved from MODIS are based on past configurations (e.g., AVHRR), which do not take full advantage of this capability. Thus a more complete utilization of MODIS type sensors is still on the way and under development. Using the FROS data, we will be able to diagnose the land surface conditions around the target region, for full use of satellite remote sensing data.

A wide variety of data sets can be expected from our ABL observation system. The resulting flux data set will be made available to the FLUXNET community. These forthcoming data sets will also be useful for the re-evaluation of parameters on ABL turbulence and entrainment process, by means of cloud resolving model (CRM).

References

Angevine, W. M., A. B. White and S. K. Avery (1994): Boundary-layer depth and entrainment zone characterization with a boundary-layer profiler. Boundary-Layer Meteorology, 68, 375 - 385.

Hong, J., T. Choi, H. Ishikawa and J. Kim (2004): Turbulence structures in the near-neutral surface layer on the Tibetan Plateau. Geophysical Research Letters, 31, L15106, doi:10.1029/2004GL019935.

Horst, T. W. and J. C. Weil (1994): How far is far enough ? The fetch requirements for micrometeorological measurement of surface fluxes. Journal of Atmospheric and Oceanic Technology, 11, 1018 - 1025.

Kaimal, J. C., J. C. Wyngaard, Y. Izumi and O. R. Cote (1972): Spectral characteristics of surface-layer turbulence. Quarterly Journal of the Royal Meteorological Society, 98, 563 - 589.

McNaughton, K. G. (2004): Turbulence structure of the unstable atmospheric surface layer and transition to the outer layer. Boundary-Layer Meteorology, 112, 199 - 221.

Applicant's information of AsiaFlux Training Course on Micrometeorology

Venue: Tsukuba, Japan Date: 21 - 30 August 2006

Online-application form and course details: http://www.asiaflux.net/aftc2006/

The deadline for the application: 31 December 2005

Please pass this information to your colleagues who will be interested.

Editor's Note

"AsiaFlux Training Course on Micrometeorology" will be held in the summer of 2006.
I hope preparations of the training course will be promising.

The editor of AsiaFlux Newsletter No.16:
Tetsuya HIYAMA
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The editor of AsiaFlux Newsletter No.17 will be Yoshiko KOSUGI (Kyoto University).

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