GEWEX Asian Monsoon Experiment

GAME Letter

No. 1 January 2000

TOWARD GAME OBJECTIVES

Tetsuzo Yasunari
University of Tsukuba
yasunari@atm.geo.tsukuba.ac.jp

The human life, economics, agriculture and ecosystem in Asia/Australia region depend deeply upon the monsoon climate and its variability. Droughts and floods associated with the monsoon rainfall variability frequently cause serious damages for the human life and ecosystem in these regions. The seasonal forecasting of monsoon rainfall and the control of water has been a matter of great concern for the people and countries in these regions.

On the other hand, the Asian summer and winter monsoon plays a major role in the global climate system and its variability, through the energy and hydrological cycle in the atmosphere-ocean-land system of this region. The interannual variability of the Asian monsoon plays a key role on triggering and modulating the ENSO in the equatorial Pacific. The variability of the monsoon, in turn, is likely to be strongly affected by the land-surface processes (snow cover, soil moisture etc.) over the Eurasian continent.

The GEWEX Asian Monsoon Experiment (GAME) was started in 1996, as part of GEWEX (Global Energy and Water Cycle Experiment) under WCRP (World Climate Research Programme), to understand the role of the Asian monsoon as a major component of the global energy and water cycle, and to understand the feedback processes, i.e., radiation, cloud, precipitation and land surface hydrology, in the diurnal cycle, and intra-seasonal, seasonal to interannual variabilities of the Asian monsoon. To assess the impact of the large-scale Asian monsoon variability on regional or basin-scale hydrological cycle and water resources is another essential objective of GAME.

In 1998, GAME Intensive Observing Period (IOP) was implemented, which included the enhanced radiosonde observations during the summer monsoon season at more than 110 upper air staions in the Asian monsoon countries. Three regional experiments with intensive observation of the surface energy and hydrological processes were also conducted in Thailand (GAME-Tropics), Huai-he river basin of central China (GAME-HUBEX) and Tibetan Plateau (GAME-Tibet). The surface hydro-meteorological processes in the cryosphere of east Siberia (GAME-Siberia) was started synchronously with the IOP. In 1999 summer, the follow-up experiments to the IOP 1998 were implemented in GAME-Tropics and HUBEX region. As part of GAME-AAN (Asian AWS Network), the long-term monitoring of the surface radiation and energy fluxes has been continued at about 10 stations covering from the Arctic coast in Siberia down to the tropical monsoon forest in Thailand.

The data collection, archive and dissimilation have been under way as part of GAME Archive Information Network (GAIN). Based upon the data obtained through these experiments and monitoring, regional atmospheric and hydrological modeling activity has started in each region as well as the whole Asian monsoon region. The four-dimensional data assimilation (4DDA) of the IOP data set is starting at Japan Meteorological Agency (JMA) and the Meteorological Research Institute (MRI).

In this sense, the GAME research activity has just started. I do believe that this GAME News will provide a very good and unique opportunity for introduction of the overall GAME activity and exchange of information among the international community of GAME.

SUMMARY AND TOPICS OF HUBEX INTENSIVE FIELD OBSERVATIONS

Yasushi Fujiyoshi
Institute of Low Temperature Science
Hokkaido University
and
Kazuhisa Tsuboki
Institute for Hydrospheric-Atmospheric Sciences, Nagoya University
tsuboki@ihas.nagoya-u.ac.jp

The energy and water cycle in the subtropical monsoon region of the East Asia is characterized largely by Baiu/Meiyu front in summer. It is one of subtropical fronts and a unique subsystem of the Asian monsoon. Cloud/ precipitation systems in Various scale are formed in this frontal zone and play major role in the energy and water cycle in this region. One of

subjects in GAME/HUBEX is to study the evolution of mesoscale cloud system. Main objectives of this study are to clarify roles of a mesoscale cloud system in time variation of regional-scale energy and water cycle and to reveal evolution of a mesoscale cloud system and its response to time variation of land-surface system. In this article, We will summarize contents of the HUBEX Intensive Field Observations which were performed in 1998 and 1999 and some topics from these observations.

1. Intensive field observation in 1998

In 1998, HUBEX group performed meteorological observation from May to August, the surface fluxes observations in each season and the intensive field observation of meteorology and hydrology in June and July (Baiu season). The following universities and institutions were participated: Hokkaido University, Nagoya University, Kyoto University, Japan, China Meteorological Administration, National Climate Center, Meteorological Bureau of Anhui Province, Huaihe River Commission, Beijing University, and Nanjing University, China. Main observations are as follows:

- radiosonde observations at 21 points 4 times a day,
- weather-radar observations at 6 points,
- Doppler radar observations at Shou-xian, Feng-tai and Huai-nan,
- dense raingauge observations,
- and flux observations in paddy field, farmland, forest and lake.

During the intensive field observation, a record-breaking flood occurred in the Yangtze River region. A large amount of important data was obtained by these field observations.

2. Intensive field observation in 1999

HUBEX group also performed meteorological observation in 1999: the surface flux observations and the intensive field observation of meteorology and hydrology in June and July (Baiu season). Main observations are as follows:

- radiosonde observations at 15 points 4 times a day,
- weather-radar observations at Fuyang,
- Doppler radar observations at Shou-xian and Feng-tai,
- dense raingauge observations,
- AWS long-term monitoring,
- and flux observations.

The long-term monitoring of the surface fluxes is continued since the last year. Synoptic-scale situation was largely different from the last Baiu season. During the intensive field observation, several types of precipitation were observed. In particular, precipitation was significant during the period from 21 June to 8 July 1999.

3. Internal structure and evolution of a meso-α-scale convective system in a Meiyu Front

A meso-α-scale convective system was formed and developed over the radar network of HUBEX on 29-30 June 1998. Heavy rainfall was caused by the system in some region with a maximum amount of precipitation being grater than 350 mm. Radar observation showed that six distinct meso-Beta-scale convective clusters had evolved in the meso-α-scale convective system. Each convective cluster consisted of one or several convective rainbands.

4. Squall line observed on 16 July 1998

After the Meiyu front moved to the north of the area, a high controlled over the basin. During the period from 11 to 19 July, convective clouds developed in the afternoon everyday. Organized convective clouds and a squall line were observed by Doppler radars. The convection was very much intense and the echo top height occasionally reached more than 17 km in height. The convective clouds were sometimes organized into a rainband. The squall line was one of the most significant event observed on 16 July 1998. A line structure was observed and it moved from the southwest to the northeast. The leading edge was clear in a vertical cross section and a rear-inflow was significant. When the squall line passed over the Doppler radar site, intense echo and lightening were observed.

5. HUBEX data center

The data obtained from the HUBEX field observations will be stored at National Climate Center, Beijing, China as well as Nagoya University, Japan, with regional 4DDA data and satellite data (GMS, NOAA, TRMM). All of data will be open for GAME-registered researchers after 1 October 2000.

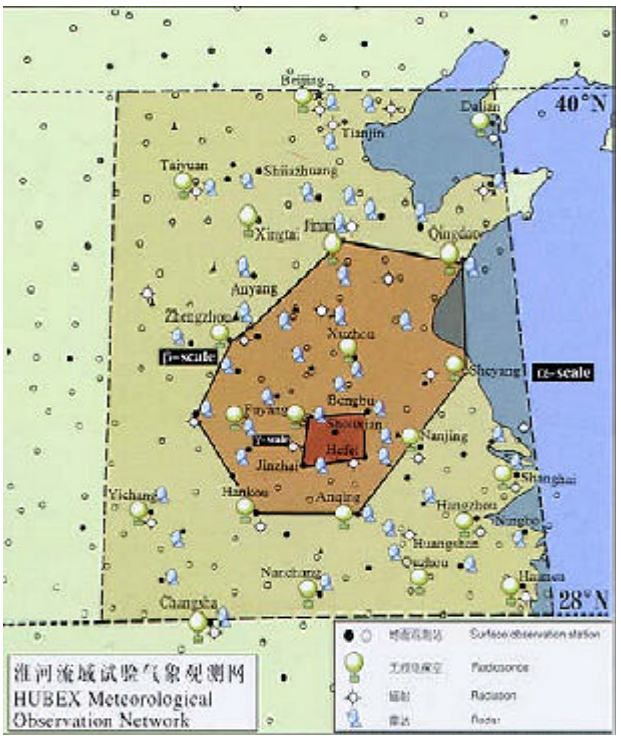
6. Workshop on Meso-scale Systems in Meiyu/Baiu Front and Hydrological Cycle

In order to exchange research results by HUBEX, we had the workshop in 3-9 November 1999 at Xi'an, China. Sessions organized in this workshop were as follows:

Session 1: Multi-scale aspects, and energy and water

cycle of Meiyu/Baiu front,
Session 2: Meso-scale cloud system,
Session 3: Boundary layer fluxes, radiation and energy budget,
Session 4: Remote sensing in the study of energy and water cycle,
Session 5: Hydrological model, its coupling with regional meteorological model and 4DDA.

Many researchers presented in each session and fruitful discussion was carried out in this workshop.



START IN THE GAME-TIBET RESEARCH PHASE

Toshio Koike
University of Tokyo
tkoike@hydra.t.u-tokyo.ac.jp

The participants of the GAME-Tibet Pre-phase Observing Period (POP) in 1997 and the Intensive Observing Period (IOP) in 1998 is making great efforts for analyzing the large amount of data obtained during the POP and the IOP. The preliminary observational results were reported at the First International Workshop on GAME-Tibet in Xi'an, China, in January 1999, and the Third International Scientific Conference on GEWEX in Beijing, China, in June 1999. This short article introduces some of interesting phenomena reported at the above two meetings.

The surface energy budget studies point out the imbalance of net radiation (Rn) with soil heat flux (G) and sensible (H) and latent (lE) heat fluxes observed by using the eddy correlation method. The residual, Rn-H-lE that is G, reaches to 300W/m^2 on a typical sunny day. The value is much greater than usual. This type of imbalance was obtained not only at one site but at several ones. This issue should be fixed through further careful data quality check. The estimated value of Qs by using the diurnal variation of the surface atmospheric pressure fell down abruptly at the onset of the monsoon.

The 3D Doppler radar was deployed for TRMM PR validation. The horizontal scale and height of echo from the TRMM PR are consistent with those by the ground-based radar, while the reflectivity values of PR is 7 dB larger than those by the ground-based radar. Meso-scale vortices were often observed in vigorous convective clouds by using the ground-based radar, as shown in Fig. 1. Rainbands were sometimes observed. In many cases, the rainbands extended from the southwest to the northeast. Clear decrease of precipitation as a function of latitude was found, but no significant relation was found with altitude by using raingauge network.

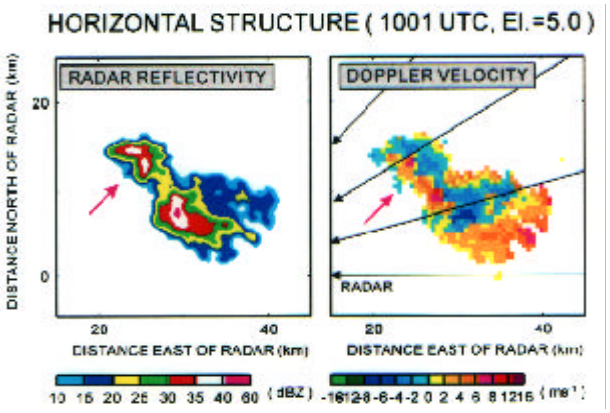


Fig.1 Meso-scale vortices observed by the 3D Doppler radar.

Figure 2 shows the seasonal and spatial variations of soil moisture and temperature profiles. Clear tendency of permafrost characteristics along the north-south line was identified. The large discrepancies of the soil temperature and moisture profiles and active layer depth along the slope were observed. Sub-surface flow is considered to play an important role on the distributions of the hydrological parameters on the

hillslope.

Two characteristic features were reported based on the analysis of precipitation isotope sampling data. One is an overall large value of d-excess, which is often used for estimating origin of water. The other is an increasing trend of d-excess during continuous precipitation periods. A global isotope circulation model was used for explaining these characteristics and suggested the importance of cloud process for high d-excess value over the Tibetan Plateau.

TRMM Microwave Instrument(TMI) was used for estimation of land-surface hydrological parameters. The estimated snow physical temperature is in good agreement with the observed surface temperature by using the infrared thermometer, although the snow depth has not been validated because the lack of the ground-based snow depth data. The estimated soil moisture corresponds reasonably to the soil moisture observed by the TDR sensor at 4cm in depth. The monthly averaged diurnal cycle of the land surface physical temperature calculated by the proposed algorithm shows the same pattern of the observed one with several K bias. The daily averaged optical depth of the precipitation field derived from the TMI is in good correspondence to the spatially averaged ground-based rain data in meso-scale.

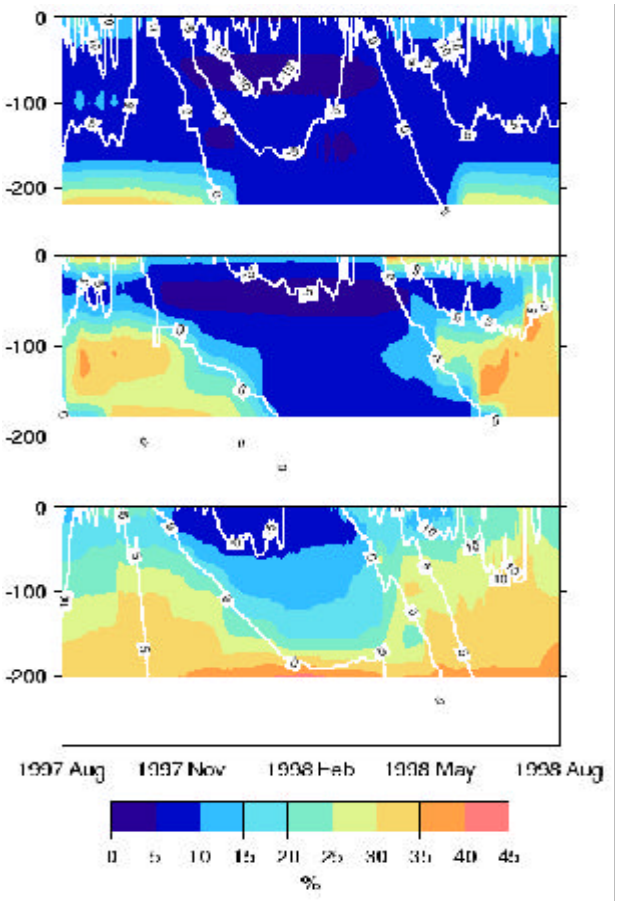
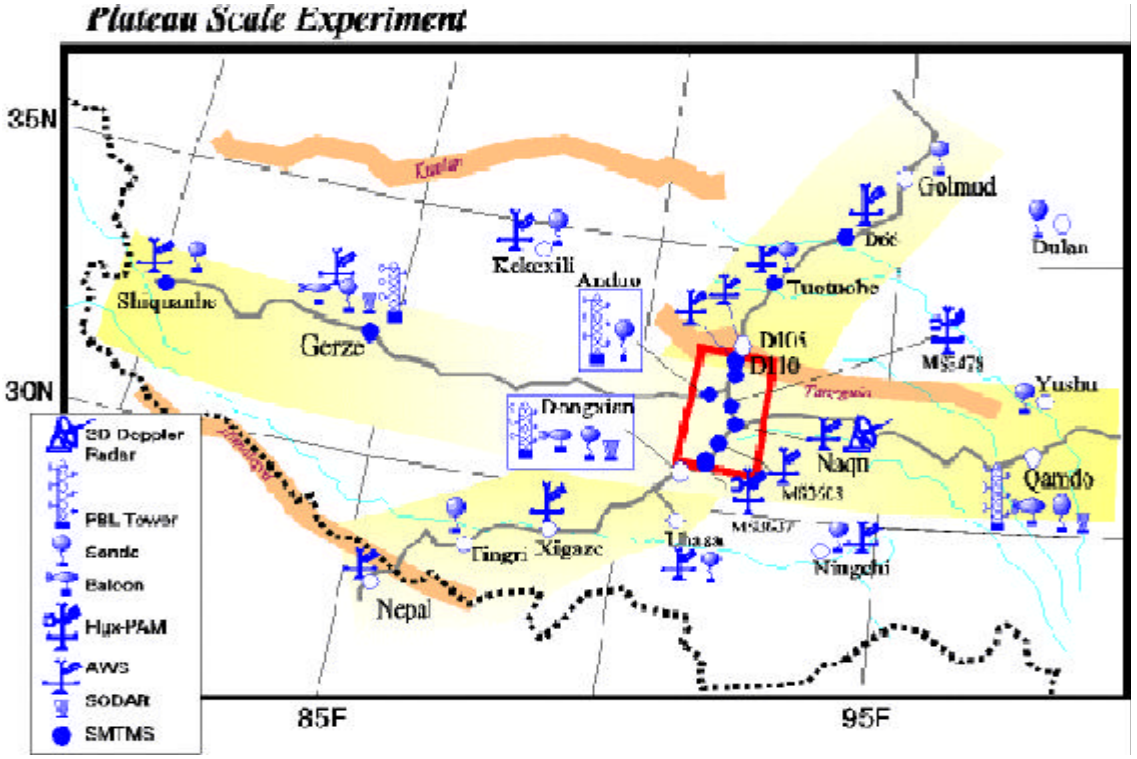


Fig.2 Seasonal and spatial variations of soil moisture and temperature profiles.



ENHANCED RAWINSONDE OBSERVATION FOR GAME-TROPICS

Akira Watanabe
Fukushima University
may@db2.educ.fukushima-u.ac.jp

It is very important to investigate cloud variations in the tropics. This is because heat sources in the tropics are mostly due to condensation of heating generated in a large number of convective clouds and driving the general circulation. The Western Pacific is the most cloud-developing region in the tropics. We started the first observation of GAME-Tropics in 1996 in Thailand, and carried out intensive observation from Apr.15 to Sep.15 in 1998 in Southeast Asia region. We observed the upper-atmospheric structure by rawinsonde four times a day at the Thai Meteorological Department (TMD) observatory. In addition, enhanced rawinsonde observation was made four or eight times a day at Nongkhai and Sukhothai in Thailand. We have analyzed these observation data to examine the diurnal and seasonal variation in the tropics.

Figure 1 shows a time-height cross section of temperature from Aug.27 to Sep.2, 1996 at Sukhothai. We can find the typical diurnal variation of temperature in the entire troposphere, and the other meteorological elements are similar situation during the rainy season. However, the typical inversion layer appears to be about 4 km above sea level during the dry season. The diurnal variation of meteorological elements is typically under the inversion layer.

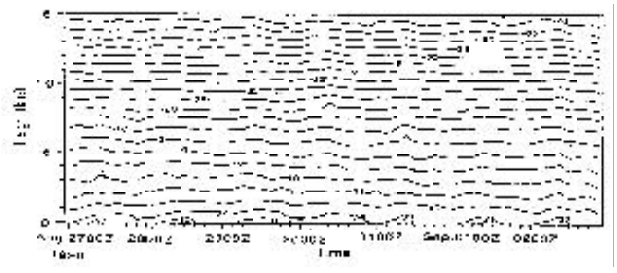


Fig.1 Time-height cross-section of temperature (°C) from Aug.2700Z to Sep.0221Z, 1996 at Sukhothai.

Figure 2 and 3 show the feature of equivalent potential temperatures in a 28-day period in the pre-monsoon period and 34-day period in the mature monsoon period which are composite using the spectra of 2, 3, 4 and 28 or 34 frequencies. Figure 2 indicates the typical 14-day periodic variation and strong convective instability is indicated in the 28-day period. On the other hand, Figure 3 indicates typical quasi-2-day variation in the entire troposphere. We can find the same situation all over the Indo-China Peninsula during monsoon period.

We believe that these periodic changes are drive by the mixed Rossby gravity wave and diurnal variation. The one-month variation is the well-known so-called Madden-Julian (1972) oscillation, and Krishnamuriti and Ardanuy (1980) have already showed the half-month variation in meteorological elements around the Indian Ocean. The quasi-2-day variation in convective activity over the Western Pacific Ocean was shown by Takayabu et al. (1996). The characteristics of composite features are very similar to their investigations.

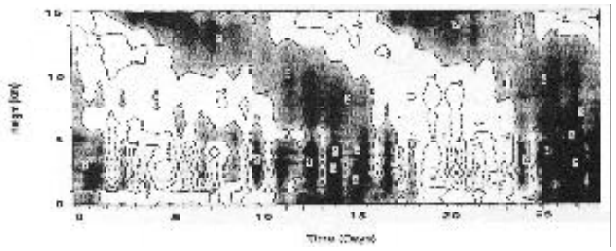


Fig.2 Time-height cross-section of equivalent potential temperature(K) 28-day period in the pre-monsoon period.

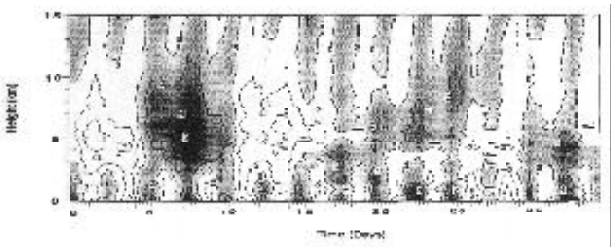


Fig.3 Time-height cross-section of equivalent potential temperature(K) 34-day period in the mature monsoon period.

References

Krishnamuriti, T. N. and P. Ardanuy , 1980: The 10-20 day westward propagating mode and “breaks in the monsoon”, Tellus, 32 15-26.

Madden, R. A., and P. R. Julian, 1972: Description of global scale circulation cells in the tropics with a 40-50 day period. J. Atmos. Sci., 29, 1109-1123.

Takayabu, Y. N., K. M. Lau and C. H. Sui, 1996: Observation of a quasi-2-day wave during TOGA COARE, Mon. Wea. Rev., 124, 1892-1913.

STATUS OF GAME TROPICS AT THE END 1900'S

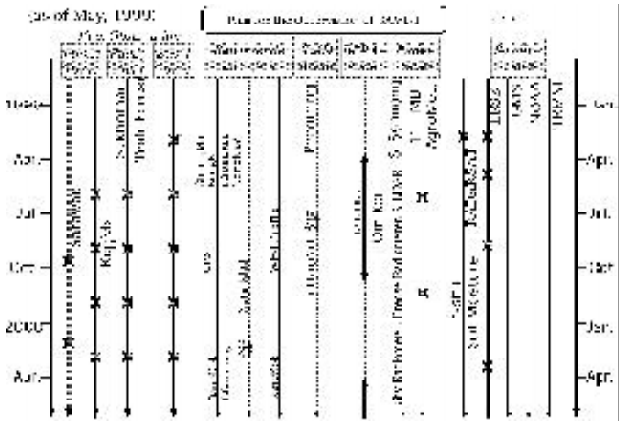
TaikanOki
Institute of Industrial Science
University of Tokyo
taikan@iis.u-tokyo.ac.jp

1. Overview

As a part of GEWEX/GAME, the objective of GAME-Tropics (GAME-T) is the quantitative monitoring of the vapor flux, precipitation, evapotranspiration, radiative flux, and of their seasonal, intra-seasonal, and interannual variation in the south-east Asia. In order to accomplish this objective, various field observations and data collections were planned and implemented. The year 1998 was the Intensive Observation Period (IOP) of GAME and organized field observations and data collections were carried out in the target region. The observations during IOP were generally successful and valuable data were obtained. The data were examined and a comprehensive dataset is now under construction. Following to the IOP year, additional observations were planned and mostly completed.

2. GAME-T Observations in 1999

Unlike other field experiments under GAME, GAME-T is still keeping the field observation systems almost as same as that were held in the IOP year, 1998. Most of these observations are summarized in the diagram.

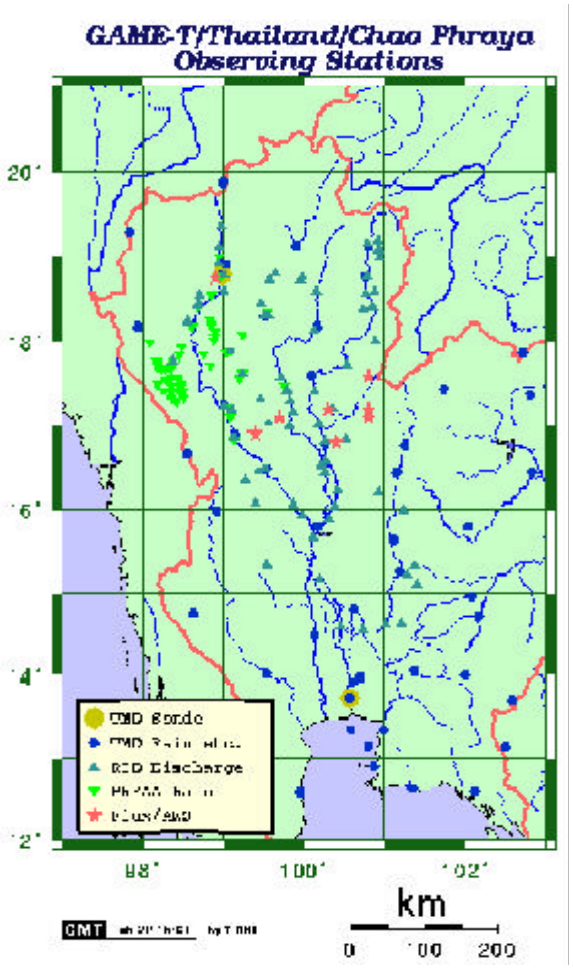


3. Flux Measurements

There are three groups measuring the fluxes between atmosphere and land surface. They are:

- Kog-Ma forest tower site near ChiangMai by the group of Prof. Suzuki
- Sukhothai paddy field by the group of Prof. Aoki
- EGAT tower site by the group of Prof. Ohte

Basically, all of these groups had/will have campaigns of enhanced flux measurements using eddy correlation instruments etc. in May, August, November 1999, and March 2000. The group of Prof. Suzuki is also contributing to the raingauge network in the MaeChaem River Basin. The group of Prof. Aoki had/will have short-term observations in various vegetation types as he did in 1998. The target in 1999 will be teak forest.



4. Rawinsonde and GPS

Due to the extensive resource consumption, there was no enhanced observation by rawinsonde at TMD operational stations in 1999. Instead there will be an enhanced observation for two weeks at NongKhai in January 2000. The target of the observation is to obtain the diurnal cycle of the vertical structure in dry season at NongKhai. Mainly for the measurements of the boundary layer of the lower atmosphere, intensive

observations were carried out at EGAT Tower station during February 15th through March 3rd, 1999 by the group of Prof. Sugita. 4 or 5 rawinsonde were released mainly during daytime and synchronized with NOAA/AVHRR, TRMM, and LANDSAT observations. GPS observation will continue long-term at Bangkok and Si Samrong by the group of Prof. Kato.

5. Radar

Data recording and frequent monitoring of precipitation by TMD operational radar was done at ChiangMai in August 1999. The Omkoi radar of BRRAA has been operated under their project named Applied Atmospheric Resources Research Program (AARRP). It will finish in the year 1999 and it will be operated under the dam operation project 2000-2005. The new project has arose 1999-2005 for the rain making research in the Northeastern region of Thailand. The new radar system has been installed at Pi Mai and similar observation, more than 10 times 3D volume scan per hour for 24 hours associated with air craft in-situ measurements, will be done. The raingauge network as well as disdrometers will be relocated to the Pi Mai radar range.

6. Radiometer and Lider

The observation by the precise radiometer and lidar at Si Samrong by Prof. Nakajima and Prof. Takeuchi is continuing in long range. The 11 radiometers were installed all over Thailand, managed by Prof. Aoki and the Agromet division of TMD, and were/will be maintained in June and December 1999. They have the target of long-term monitoring, as well.

7. Future Perspective

Prof. T. Koike introduced the following project after the current GAME project. The proposed project is called Coordinated Enhanced Observational Period (CEOP). The idea will be described in another article or report, but the major concepts are as follows:

- The established observational system related to GAME is precious. The system should be used for long-term monitoring of the climate change and its variability in the GAME target regions.
- The GAME project is emerging new research activities in the regions and such kind of activities should be continued.
- The ground observation systems are important for the validation of satellite measurements. In the year from 2001 through 2002 will be the era of Earth Observing System (EOS) and the heritage of GEWEX/GAME field measurement framework will contributed.

In the discussion at the GAME-T Workshop in Kanchanaburi in March 1999, the proposal was warmly accepted with positive comments. CEOP is planned to start in the year 2001 and will be discussed in detail in the GAME-T workshop which will be held near Bangkok in March 2000.

QUICK RESEARCH REPORT

APPLICATION OF SIB2 TO GAME-TROPICS IOP98 DATA

Takashi Arai, Wonsik Kin, Taikan Oki and Katumi Musiake
Institute of Industrial Science
University of Tokyo
taikan@iis.u-tokyo.ac.jp

SiB2 (Sellers et al., 1996) is one of the latest Land Surface Model, and the source code of the one-dimensional version of SiB2 is opened to the public. Compared with the original SiB, the new version is incorporated with a realistic canopy photosynthesis-conductance model in order to describe the simultaneous transfer of CO_2 and water vapor into and out from the vegetation.

In this study, SiB2 was applied to the observational data at a tropical paddy field. These data was collected by micrometeorological observational system over paddy field in Sukhothai, Thailand during GAME-T IOP. Flux data were calculated by the Bowen-Ratio Method using net radiation, soil heat flux, water heat storage and temperature and water vapor at two height.

Comparison of simulated heat fluxes with observed values on 21st and 22nd October in 1998 (LAI=5) is shown in Fig. 1. Latent heat flux (LE) and sensible heat flux (H) were well simulated, and simulated ground heat flux (G) is almost equal to the sum of observed G and water heat storage (W). In this case, daiural variation of the heat fluxes were well simulated by SiB2.Comparison of simulated heat fluxes with observed values on 21st and 22nd August in 1998 (LAI=1) is shown in Fig. 2. LE is underestimated and H is overestimated, and simulated G is also larger than the sum of observed G and W. In the case of small LAI, exchange of energy and water

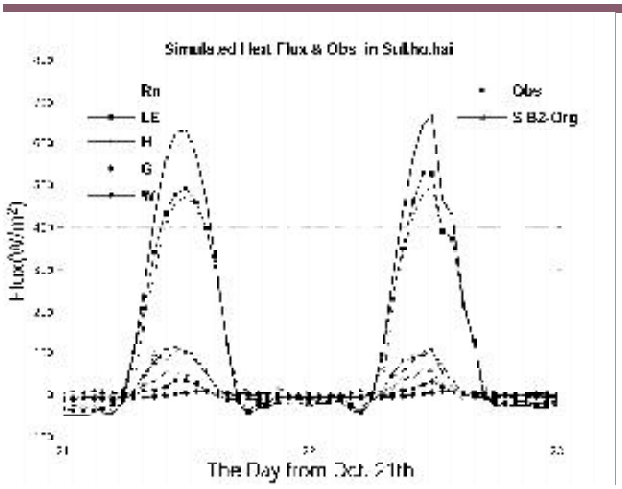


Fig. 1 Comparison of the heat fluxes simulated by original SiB2 with observed values at Sukhothai paddy field (LAI=5), October 1998. Rn:net radiation, LE: latent heat flux, H:sensible heat flux, G:ground heat flux,W:water heat storage.

is conducted mainly at water surface under canopy layers. Therefore, evaporation from water surface is large. On the contrary, in SiB2, capacity of surface water storage is too small to store enough water realistically. As a result, soil surface becomes dry quickly, evaporation from surface is suppressed, and LE is underestimated.

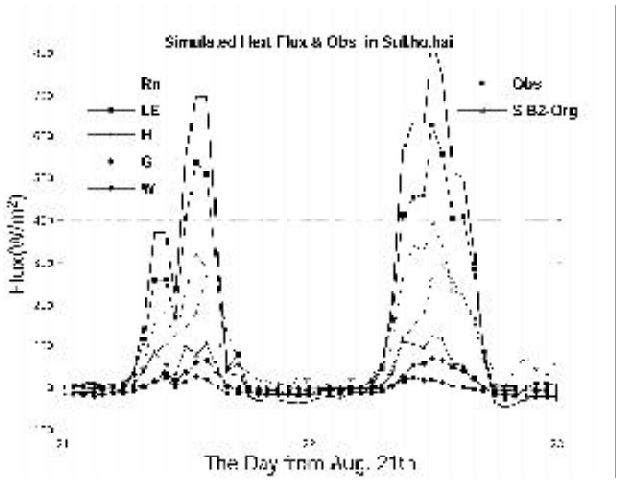


Fig.2 Same as Fig. 1 but for August 1998, LAI=1.

In order to make up for these defects, SiB2-Pad in which water body is taken into account was developed. In original SiB2, surface water storage is for puddle storage, but in SiB2-Pad,is corresponded to paddy field, soil surface is prevented from being dry and surface water storage is evaluated realistically. Further, water temperature is made from ground temperature independently and then a heat balance equation is revised for representing realistic water heat storage at paddy and the heat flux from water surface.

In the test run by SiB2-Pad, variation of water depth was simulated well by adjusting soil conductivity. Simulated water temperature was a little underestimated during night time, but was much close to observed values compared with ground surface temperature simulated by original SiB2.

Comparison of the heat fluxes simulated by SiB2-Pad with observed values on 21st and 22nd August in 1998 (LAI=1) is shown in Fig. 3. LE and H were simulated well. As the result, the heat fluxes are also well simulated under small LAI by SiB2-Pad, and estimations of the heat fluxes over paddy field have become possible in all of the year. Since the paddy field is one of popular land cover in the South East Asia, such a modification to a land surface model should be relevant for the various scales of modeling study in the region. The developed SiB2-Pad is now under coupling with a GCM and a regional climate model for further investigations of the energy and water cycles.

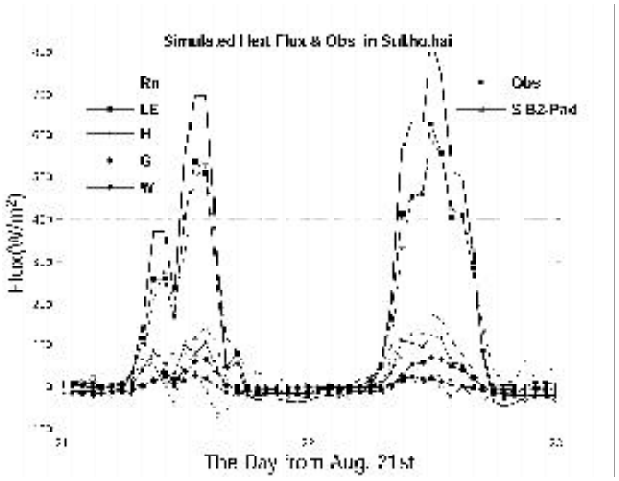


Fig.3 Same as Fig. 2 but simulated by SiB2-Pad.

Acknowledgments

The authors would like to extend their best thanks to Prof. M. Aoki for his efforts to collect the energy and water fluxes data at Sukhothai paddy field used in this note.

References

Sellers, P.J., D.A. Randall, G.J. Collatz, J.A. Berry, C.B. Field, D.A. Dazlich, C. Zhang, G.D. Collelo, and L. Bounoua, 1996:A revised land surface parameterization (SiB2) for atmospheric GCMs.

Part 1: Model Formulation. J. Climate, 9, 676-705.
Arai, T., W. Kim, T. Oki, and K. Musiake, 2000: Application of SiB2 to a tropical paddy field and inclusion of water body, Annual Journal of Hydraulic Engineering, Japan Society of Civil Engineers, submitted.

GAME-SIBERIA

Tetsuo Ohata
Institute of Low Temperature Science
Hokkaido University
ohata@pop.lowtem.hokudai.ac.jp

1. Present status

The in-situ local scale observation in Lena River basin faced its 3rd year. Data analysis and modelling activities are proceeding.

2. Progress to now

During the 1996-1999, the following results have been obtained.

(1) Full year observation of the land-surface heat/water exchange in local sites at flat taiga: The seasonal progress of heat (water) fluxes were clarified. Influence of the snow cover seemed to be low during snow covered season, evaporation rose clearly in relation to blooming of the trees. Evaporation amount during this few years seem to be lower than the result of past studies.

(2) Full year patch scale and drainage scale observation at tundra area facing Arctic Ocean: Biased distribution of snow cover characterizes runoff. Unexpected high runoff occurred in August in 1997 and 1999, but not yet explained. Thaw depth has rather high variability within small area, which may regulate subsurface flow. Surface heat fluxes depends upon wind system in this region.

(3) Application of stable isotope to understand the water exchange in the land-surface system: This method is very fruitful for tracking the movement of water and speculating large scale water movement.

(4) Development and evaluation of water circulation model in the drainage scale in permafrost zones: Existing model can simulate the runoff fairly well for winter but not yet for the annual cycle.

(5) Development of atmosphere-vegetation-ground system model in permafrost zones: One dimensional model were tested to taiga condition and seem to be applicable with slight tuning.

(6) Obtain information on vegetation conditions, snow cover characteristics and soil moisture from satellite data.: Study on vegetation and snow cover is being made

(7) Collect and archive past hydro-meteorological dataset, and satellite data.

(8) Establish long-term automatic observation system: Tower and mast observation systems are perfectly functioning under severe cold condition.

(9) Large scale water budget analysis: Analysis of atmospheric water budget based on objective–analysis shows that strong convergence year seem to be proceeded by high evaporation year.

(10) Large scale hydrological model: The two have been tested to the Lena River Basin. Both have limited applicability yet.

2. Year 2000 IOP

The overall objective of the Intensive Observation Period (IOP) is to "study the seasonal evolution of water/energy dynamics in the forested area predominating in Siberia"

2.1 Following new measures will be undertaken in the year 2000:

(1) The water/heat exchange work will be extended to different surfaces such as sparse forest, younger larch forest and grassland.

(2) Aircraft will be used to measure the spatial distribution of the sensible and vapor fluxes, and related surface parameters.

(3) A one-dimensional heat/water exchange model and a meso-scale atmospheric model will be tested against the spatial data of these various sites to check their performance and applicability.

(4) Processes related to land water storage (lake) in this region will be examined.

2.2 Questions to be answered.

(a) What are the response characteristics of the Siberian land surface to seasonal variation in atmospheric forcing? How is the influence of snow cover, permafrost and vegtation differ?

(b) Can existing atmosphere, land surface models simulate Siberian condition?

2.3 Site and period.

Target study area is north of the Yakutsk area connecting the Spasskaya Pad area and the Tungulu area(alas area) during April to June 2000.

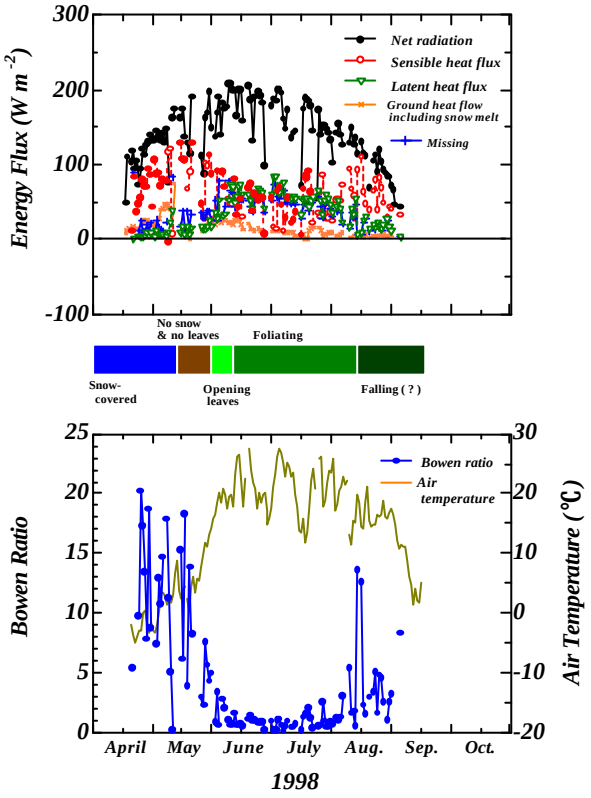
2.4 Main observation system to be employed.

Surface: Left bank(Spasskaya): 2 forest towers (larch, pine)

Right bank(Tunguru): 1 forest tower, 2-3 grass land masts

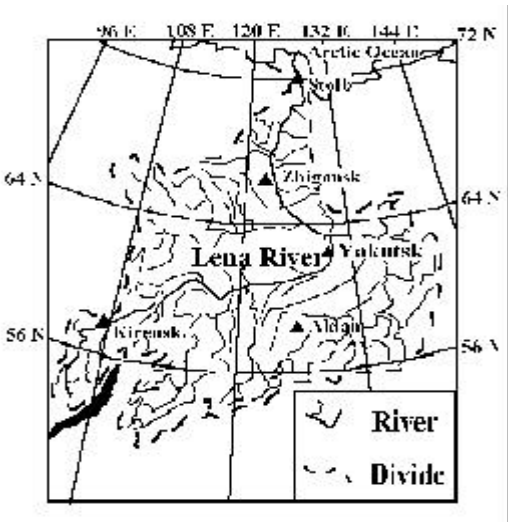
Aircraft: Mean meteorological values, fluxes (fast response wind, temp., humidity), Isotope and CO_2.

Enhanced radiosonde observation: 5 sites in vicinity of Yakutsk.



Seasonal Variation in Energy Blance in the Larch Forest, Eastern Siberia

Latent heat is corrected by the relation between eddy method and budget method



RESULTS OF GAME-IOP '98 FROM GAME-AAN

Shin Miyazaki, Michiaki Sugita, Tetsuzo Yasunari
Institute of Geoscience, University of Tsukuba
shin@erc2.suiri.tsukuba.ac.jp
and
Osamu Tsukamoto
Department of Earth Sciences
Okayama University

1. Introduction

The objective of GAME-AAN (Asian Automatic weather station Network) is to monitor the seasonal and annual variations of surface fluxes of momentum, heat, and radiation as well as variation of soil moisture on the continental scale, as the part of GAME scientific activities. GAME-AAN also supports the regional studies, particularly their intensive field experiments.

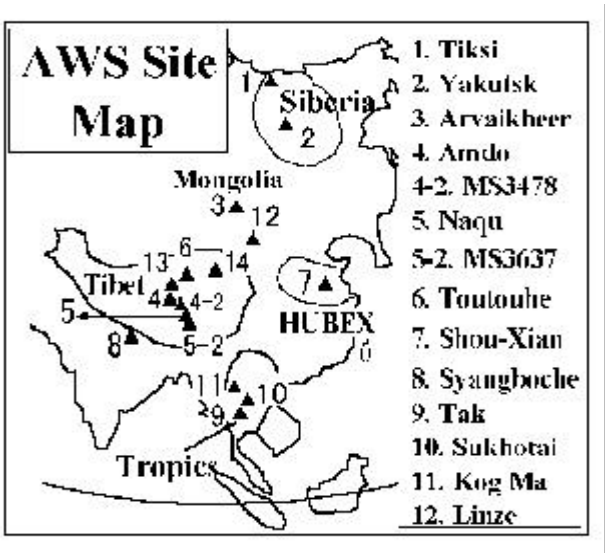


Fig.1 The location map of GAME-AAN sites.

GAME-AAN has 16 Automatic Weather Stations (AWSs) installed in Eurasian Continent from autumn in 1996 as shown in Fig. 1. Prior to GAME-IOP '98, most of the AWSs were in operation. We adopted six types of AWSs for our observation. A Portable Automated Methonet (PAM) III station being developed at National Center for Atmospheric Research (NCAR) in U.S., was chosen to use for the half of the AWSs network at Arvaikheer (Mongolia, grassland), Shouxian (China, paddy), MS3478 (Amdo, China-Tibet, grassland), MS3637 (Naqu, China-Tibet, grassland) and Tak (E-GAT, Thailand, tropical bush

forest). The MS3478 and MS3637 were operated only in the period of GAME-IOP'98 and they have been moved to Linze (China, desert) and Toutouhue (China-Tibet, grassland), respectively since 1999. PAM III has a 3D sonic anemometer and a hygrothermometer to determine surface turbulent fluxes of momentum, heat and water vapor by applying an eddy correlation technique and bandpass covariance method, respectively. PAM III also has the capability to transmit the data via a geostationary satellite. This capability can allow real time monitoring the status of PAM III at the same time data acquisition. However, currently only one station in Mongolia uses this data transmission. An Automatic Climate Observation System (ACOS) was chosen for two AWSs at Tiksi (Tundra) and Yakutsuk (Taiga) in Siberia. This system is designed for snowy-low temperature condition. Another types of AWSs was chosen at MS3608 (Naqu), D110, D66, and Toutouhe on the grassland in Tibetan Plateau. These systems were previously used for the Heife River basin experiment. In Thailand, AWSs were installed at Sukhothai (paddy field) and Kog Ma (monsoon forest). At Syangboche (Himarayan mountain) in Nepal the AWS has been operated by the CREH since 1994.

2. Results

Here we report only the result observed in Tibetan Plateau during GAME-IOP '98, because the continuous surface flux data was obtained from PAM III at the MS3478. From this observation, we can find the seasonal march of the surface heat fluxes in the pre-monsoon season and the maturing phase of monsoon. Previous studies show that permafrost has large impact to the surface energy budget over the Tibetan Plateau, and the energy and water cycles over this region play an important role in the Asian monsoon system.

Figure 2 shows the time series of daily mean values of air temperature and mixing ratio. Abrupt increase of mixing ratio occurred in late June, with one week lag to the abrupt increase of air temperature. Air temperature decreased suddenly in late August but the mixing ratio decreased rapidly in early September. Figure 3 shows the time series of daily precipitation and daily mean soil moisture. It has the large amount of precipitation from late June to late August, which has been considered as the mature phase of monsoon. From Fig. 3, the onset and the offset of monsoon were the middle June and early September, respectively. Although the soil moisture decreased from 40% to 30% during pre-monsoon, it has increased from 30% to 40% during monsoon. The soil of this site was nearly saturated, because the permafrost under the ground played as impermeable layer. Therefore the increase of soil moisture was not so sensible to the precipitation.

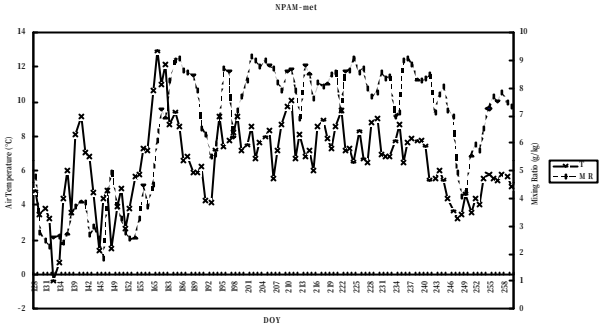


Fig.2 Time series of daily mean values of air temperature and mixing ratio at MS3478 in Tibetan Plateau during GAME-IOP '98.

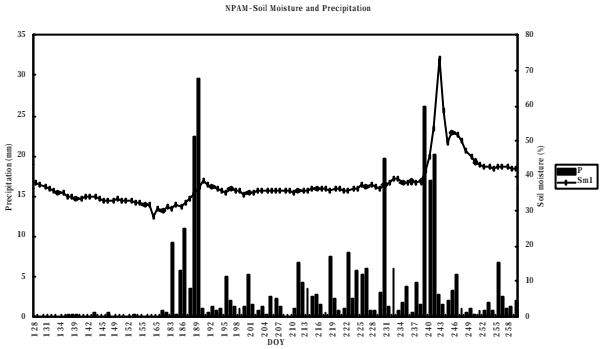


Fig.3 Time series of daily precipitation and surface soil moisture observed at MS3478 in Tibetan Plateau during GAME-IOP '98.

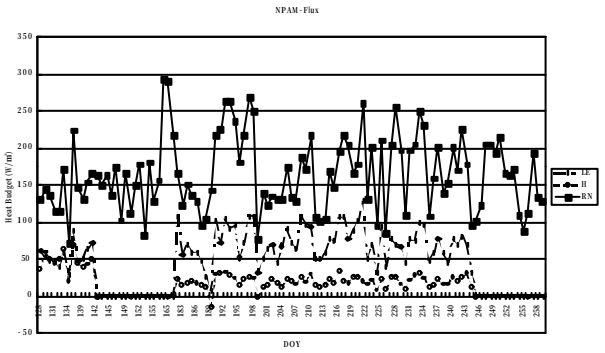


Fig.4 Time series of daily mean heat balance observed at MS3478 in Tibetan Plateau during GAME-IOP '98.

Figure 4 shows the time series of daily mean values of heat budget. In pre-monsoon, the sensible heat flux and latent heat flux were almost same value, however, the latent heat became about three times of sensible heat flux in monsoon. It made the abrupt increase of mixing ratio because of large amount of precipitation.

GAME-RADIATION ACTIVITIES

Teruyuki Nakajima
Center for Climate System Research
The University of Tokyo
teruyuki@ccsr.u-tokyo.ac.jp

The GAME-Radiation Activities study the radiation budget in the Asian region through surface measurements and satellite remote sensing. For this purpose, two high-precision radiation sites have been established since 1997 at Sri-Samrong, Thailand and Shou-Xian, China under multi-country collaboration of Japan, Thailand and China. Shortwave and longwave radiative fluxes are measured at these sites, as well as auxiliary data for evaluating the theoretical radiation budget from a sky radiometer, GPS sensor, and MPL lidar (only at the Sri-Samrong site). Data from these sites, which are archived at Center for Environmental Remote Sensing of Chiba University and Center for Climate System Research of the University of Tokyo, now start providing useful information for understanding the magnitude of radiative budget in these regions. A preliminary analysis showed that the observed surface shortwave radiation budget at the Sri-Samrong is well reconstructed from theoretical water vapor and aerosol radiative forcings. The magnitude of the aerosol forcing was evaluated as large as 40 W/m^2 in the period of January – March of 1998. It will be extremely useful to continue such study at several sites in Asia including these sites, since the surface radiation budget is scarcely understood over continental scale area of Asia. Especially accurate evaluation of the climate forcing of anthropogenic aerosols is important, as revealed by the large Indonesian forest fire event in 1997. In this event the total burnt area was estimated as 552 kha (Liew et al., 1999) and aerosol emission as 5.6 Mton (Nakajima et al., 1999).

These two radiation sites in Thailand and China are at the same time 'super sites' in a sky radiometer network in Asia, called SKYNET, which has been established by university scientists and National Space Development Agency of Japan (NASDA). Main sites are as listed in Table 1, where the sky radiance and downward shortwave radiative flux are observed. The Shou-Xian site has been replace from 1999 by a Hefei site to continue a long-term measurement of the surface radiation budget.

Satellite remote sensing studies are also an important activity of the GAME-Radiation Activities. An algorithm has been developed for retrieving the surface radiation budget from GMS satellite. A preliminary study showed that monthly mean values of downward shortwave radiative flux from the satellite well agree with surface-measured values at SKYNET sites. Further improvement of the satellite algorithm is now being tried with introduction of global distributions of optical thickness and Ångstöm exponent of aerosols over ocean derived from a two channel method of AVHRR and ADEOS/OCTS (Nakajima and Higurashi, 1998; Higurashi et al., 2000).

Table 1: Radiation data archives by the GAME-Radiation.

Site	Archive period
High Precision Sites	
A1 Si-Samrong (17.17N, 99.87E)	1997/06 1998/06
A2 Shou-Xian (32.55N, 116.78E)	1997/12-1998/10
SKYNET	
B1 DunHuang (40.16N, 94.80E)	1998/10
B2 Hentona (26.86N, 128.25E)	1996/03-1997/07 (stopped)
B3 Mandalgovi (45.59N, 106.19E)	1998/07-08
B4 Minamitorishima (24.30N, 153.97E)	1997/10 -1998/07 (stopped)
B5 Niigata (35.74N, 139.32E)	1997-1998 (stopped)
B6 Tsukuba (36.01N, 140.01E)	1995/07 -1997/09
B7 Lhasa (40.14N, 94.66E)	1998/08-10
B8 Yinchuan (38.48N, 106.22E)	1997/12-1998/07

References

Higurashi, A., T. Nakajima, B. N. Holben, A. Smirnov, R. Frouin, B. Chatenet, 2000: A Study of Global Aerosol Optical Climatology with Two Channel AVHRR Remote Sensing, J. Climate, in press.

Liew, S. C., L. K. Kwoh, K. Padmanabhan, O. K. Lim, and H. Lim, 1999: Delineating land/forest fire burnt scars with ERS interferometric synthetic aperture radar. Geophys. Res. Lett., 26, 2409-2412.

Nakajima, T., and A. Higurashi, 1998: A use of two-channel radiances for an aerosol characterization from space. Geophys. Res. Lett., 25, 3815-3818.

Nakajima, T., A. Higurashi, N. Takeuchi, and J. R. Harman, 1999: Satellite and ground-based study of optical properties of 1997 Indonesian forest fire aerosols. Geophys. Res. Lett., 26, 2421-2424.

Fig.1 A high precision radiation site at Sri-Samrong,Thailand.

GAIN (GAME ARCHIVE AND INFORMATION NETWORK)

Kiyotoshi Takahashi
Climate Research Department
Meteorological Research Institute, JMA
ktakahas@mri-jma.go.jp

As many countries are involved in the GAME project, data policy has been one of important issues. We have reached the agreement about the data policy at the GAME International Science Panel (GISP) at Tokyo in January 1998.

According to the guideline adopted at the GISP, the time schedule of data dissemination is as follows.

1.Data obtained as part of the observations during the IOP will be made available according to the following schedule.

- By the end of June 1999 (6 months after the IOP), for the participating institutes and scientists.
- By the end of June 2000 (one year later), for the international research community.

2.Data obtained as part of the GAME observations during the non-IOP will be made available according to the following schedule.

- By the end of one year after the observation, for the participating institutes and scientists.
- By the end of two years after the observation, for the international research community.

However, I have to note that there exist some exceptions in the above schedule.

The first case is HUBEX. The schedule for data open is as follows.

- After one year for HUBEX-related researchers
- Two years for GAME-related researchers
- Three years for GEWEX-related researchers (International research Communities)

The second is data for Tibetan region. Observations in Tibetan Plateau were conducted by following three groups,

GAME-Tibet (one component of GAME),
TIPEX (Chinese national research program)
JEXAM (Japanese research program supported by STA of Japan).

Data policy for Tibetan data has been discussed in the JCC(Joint Coordinate Committee) which was composed of three groups above-mentioned.

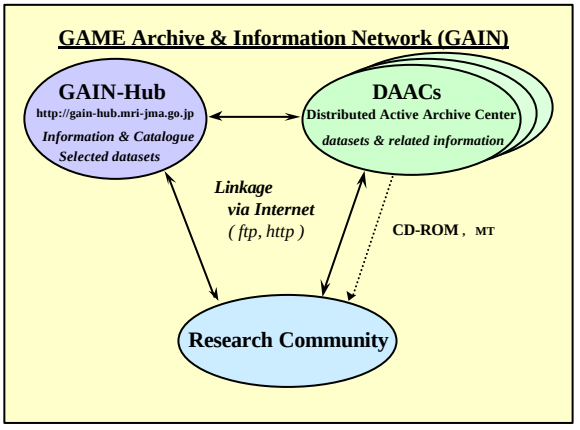
The latest agreements concerning data policy are as follows.

1.Data policy of GAME-Tibet is the same as the GAME general policy.

2.In the case of TIPEX and JEXAM,

- After one and two years data will be opened to JCC members depending on the data level.
- After three years, data will be opened to international research communities.

As for the systems of data archiving, GAME archive and information network (GAIN) consists



Current status of GAIN DAAC

DAAC	Data	Method & *Contact person*
GAIN-Hub	・GAME Data Catalogue Information ・4DDA data (Objective analysis data & 2-D physical monitor data) ・Linkage to other DAAC for data provision	**http://gain-hub.mri-jma.go.jp (GAIN Home Page)** *Kiyotoshi Takahashi (MRI/JMA)* *E-mail: ktakahas@mri-jma.go.jp, Tel/Fax:+81-298-53-8670/55-2683* *5th Research Lab./Climate Research Dep./Meteorological Research Institute* *Nagamine 1-1, Tsukuba, Ibaraki 305-0052*
	Intensive Radio-sonde data	ftp://ftp.kurasc.kyoto-u.ac.jp/pub/private/game-t/sonde (not yet available) *Akira Watanabe (Faculty of Education, Fukushima University)* *E-mail: may@db2.educ.fukushima-u.ac.jp, Tel/Fax: +81-24-548-8203*
	Radar data atChiang Mai, Phitsanulok, Khon Kaen	8mm/DLT, IIS,university of Tokyo *Taikan Oki (Institute of Industrial Science, University of Tokyo)* *E-mail: taikan@iis.u-tokyo.ac.jp, Tel/Fax: +81-3-3402-6231(ext.2528)/2597*
Tropics	Hydrological and meteorological routine data	http://rdp.dpri.kyoto-u.ac.jp/hydrodata/thailand.html (not yet available) http://hydro.iis.u-tokyo.ac.jp/~GAME-T/Data/hydro (not yet available) ftp://hydro.iis.u-tokyo.ac.jp/~GAME-T/Data/hydro (not yet available) *Shinjiro KANAE (Institute of Industrial Science, University of Tokyo)* *E-mail : kanae@iis.u-tokyo.ac.jp, Tel/Fax : +81-3-3402-6231(ext.2527)/2597*
	Micro meteorological observation data (a) Flux observation at sukhothai paddy field (b) Solar radiation at 11 TMD agrometeorological stations (c) Flux observation at kog-Ma (hill evergreen forest) (d) Flux observation at EGAT Tower (GAME-AAN/AWS,Flux-PAM data)	**http://www.suiri.tsukuba.ac.jp/Project/aan/aan.html** **ftp://erc2.suiri.tsukuba.ac.jp/pub/GAIN/** 8mm/DLT, ERC., Tsukuba university Faculty of Agricuture, University of Tokyo, for SAT raw data *(a),(b) Masatoshi Aoki (Tokyo University of Agriculture and Technology)* *E-mail: aoki.mas@cc.tuat.ac.jp, Tel/Fax: +81-42-367-5727/6078* *(c) Masakazu Suzuki (School of Agricultural and Life Science, Univ. of Tokyo)* *E-mail:suzuki@fr.a.u-tokyo.ac.jp,Tel/Fax: +81-3-3812-2111(ext.5234)/5802-2930* *(d) Nobu Ohte (School of Agricultural Sciences, Kyoto University)* *Tel/Fax: +81-75-753-6093/6088*
	・Satellite data ・GPS data at 5 stations in Thailand	8mm/DLT, I.I.S., university of Tokyo *Toshiyuki Nakaegawa (MRI/JMA)* *E-mail: tnakaegawa@mri-jma.go.jp, Tel/Fax: +81-298-53-8601/55-2552*
	Wind profile observed by KMITL wind profiler	**http://www.crl.go.jp/ck/ck121/windprof/wp-data.html** *Yuichi Ohno (Communication Research Laboratory)* *E-mail: ohno@crl.go.jp, Tel/Fax: +81-42-327-6946/6666*
	Rainfall measurement with 12 gauges in a mountainous river basin (Mae Chaem river basin)	*Koichiro Kuraji (Tokyo Institute of Technology)* *E-mail: kuraji@depe.titech.ac.jp, Tel/Fax: +81-45-924-5548/5519*
	Rawinsonde observation at EGAT-Tower	**ftp://erc2.suiri.tsukuba.ac.jp/pub/GAME-T/** *Michiaki Sugita (University of Tsukuba) E-mail: sugita@atm.geo.tsukuba.ac.jp*

*Bold face indicates that the address is already available. As of December 9. 1999

DAAC	Data	Method & *Contact person*
Siberia	(1)Hydrological data (2)Surface meteorological data (3)Land-atmosphere boundary data in forest (4)Land-atmosphere boundary data in tundra	anonymous ftp at Tsukuba and Nagoya universities etc. **http://www.ihas.nagoya-u.ac.jp/game/siberia/dataset1.html** (1),(2) *Rikie Suzuki (IGCR/FRSGC-Tsukuba)* *E-mail: suzuki@frontier.bosai.go.jp* (3) *T. Ohta* (4) *Y. Kodama*
HUBEX	・Intensified radio-sonde observation data ・Regional-scale four dimensional assimilation data ・Conventional radar reflectivity data, raingauge data ・Doppler radar data.	All data will be provided through the internet 4 & 8 mm tape (restricted) **http://www.ihas.nagoya-u.ac.jp/game/GAME-HUBEX.html** *Ding Yihui (National Climate Center, CMA) at Chinese side* *Kazuhisa Tsuboki (IHAS, Nagoya University) at Japanese side* *E-mail: tsuboki@ihas.nagoya-u.ac.jp, Tel/Fax: +81-52-789-3493/3436*
4DDA	・Objective analysis data & 2-D physical monitor data	8 mm tape (from **GAIN-Hub**) *Ken-ichi Kuma, Toshikazu Nishio (Numerical Prediction Division, JMA)* *kumaken@naps.kishou.go.jp, nishio@naps.kishou.go.jp* *Tel/Fax: 03-3212-8341(Ext.3315)/3211-8407*
Satellite	・Snow water equivalent on the Eurasian continent derived from SSM/I ・Surface wetness on the Eurasian continent derived from SSM/I-every 5 days average	Basically 8mm tape. FTP is partially available (after Jan.,1998). **http://monsoon.nagaokaut.ac.jp** **ftp://monsoon.nagaokaut.ac.jp** *Toshio Koike(Univercity of Tokyo) E-mail: tkoike@hydra.t.u-tokyo.ac.jp* *Toshiro Kumakura (Nagaoka University of Technology)* *E-mail: kumakura@voscc.nagaokaut.ac.jp.* *Tel/Fax:+81-258-46-6000(ext.6125)/47-0019*
Radiation	(1) one minute mean and sigma for short/long up/downward (2) radiation at Si-Samrong(Thailand) and Shou-Xian(China) (3) one minute mean profile of atmospheric extinction coefficient (/m) at Si-Samrong (Thailand)	**ftp://atmos.cr.chiba-u.ac.jp/pub/game** (1) *Tadahiro Hayasaka (Tohoku Univ.) E-mail: hayasaka@mail.cc.tohoku.ac.jp* (2) *Teruyuki Nakajima (CCSR/Univ. of Tokyo) E-mail: teruyuki@ccsr.u-tokyo.ac.jp* (3) *Nobuo Takeuchi (Chiba University) E-mail: takeuchi@rsirc.cr.chiba-u.ac.jp*
AAN	・Hydro-meteorological quantities from automatic weather stations at Tiksi, Yakutsk (Russia), Arvaikheer(Mongolia), Amdo, Naqu, Toutouhe, Shou-Xian (China), Syangboche (Nepal), Tak, Sukhotai (Thailand)	**http://www.suiri.tsukuba.ac.jp/Project/aan/aan.html** *Rikie Suzuki (IGCR/FRSGC-Tsukuba)* *E-mail: suzuki@frontier.bosai.go.jp, Tel/Fax: +81-298-53-4400/51-9764* *Nobuhiko Endo (IGCR/FRSGC-Tsukuba)* *E-mail: endo@ frontier.bosai.go.jp* *Sugita Michiaki (University of Tsukuba)* *E-mail: sugita@atm.geo.tsukuba.ac.jp*
Kormex	・Upper-air soundings ・radar data ・Meteorological synoptic sfc data ・Buoy & aerological data (AMOS)	CD-ROM for KORMEX data -other types of media - an 'anonymous ftp' - **http://chaos.metri.re.kr/kormex/english/** *Won-Tae Kwon (Meteorological Research Institute,KMA)* *E-mail: wontk@iris.metri.re.kr, Tel/Fax: +82-2-846-2852/2853* *Seung-On Hwang (Meteorological Research Institute,KMA)* *E-mail: hwangso@iris.metri.re.kr*

DAAC	Data	Method & *Contact person*
GAME-Tibet	(1) Land-surface - atmosphere interaction a. 5 AWSs along the Tibetan highway b. 2 AWSs in the west (by JEXAM) c. PBL Tower at Amdo d. Turbulent flux mesurement at Amdo and Korean sites e. Intensive radio-sonde observation at Amdo f. Barometer network (2) Precipitation and cloud studies a. 3-D Doppler radar: 4 months, 10 minutes interval b. Rain gauges c. Microwave radiometer at Naqu d. GPS at Amdo (3) Land surface monitoring by satellite RS Ground truth data (4) Cold region hydrology including permafrost study a. Soil moisture/temperature at the 8 sites along the Tibetan highway b. Evaporation c. Slope hydrology d. River discharge (5) Isotope Study on Precipitation and Surface Water Isotope sampling: precipitation, river water, soil water	CD-ROM (by the end of June, 1999) **http://monsoon.nagaokaut.ac.jp/tibet/index.html** *Toshio Koike (Nagaoka University of Tech.)* *E-mail: tkoike@nagaokaut.ac.jp, Tel/Fax: +81-258-47-9667/9673*
India	radio-sonde (Surface, rainfall, radiation, marine data)	FD, MT, Cartridge tape or from **GAIN-hub** *Dr. U.S.De (Additional Director General of Meteorology (Research), IMD)* *E-mail: IMD-PUNE@X400.nicgw.nic.in, Fax: 091 0212 323201*
China	(1) TIPEX Sonde observation PBL tower, etc. (2) HUBEX	CD-ROM HUBEX Data Center (1) *Xu Xiangde (CAMS, CMA)* (2) *Ding Yihui (National Climate Center, CMA)*

of GAIN-Hub and several distributed active archive centers (DAACs). GAIN-Hub's function is mainly to provide general catalogue information on GAME data. On the other hand, each DAAC, which is maintained by each observation group, provides his own GAME data and related information. These sites are linked with each other via the Internet, and will provides GAME data basically by ftp or http protocol (see figure). Some sites have already been in operation. The above is the basic strategy of data dissemination in the GAME project. Recently, however, we feel that CD-ROM is one of common and useful media in data exchange. So at the GISP of June 1999 we confirmed the necessity to make an effort to provide GAME data with CD-ROM as possible as we can.

Finally, to get more detailed and latest information, please access to the GAIN-Hub page (http://gain-hub.mri-jma.go.jp). You can find any data site by trailing linkages starting from there. Now we are preparing GAME data towards time limit for data open, June 2000. See you again on the Net !

GAME INTERNATIONAL CONFERENCE AND THE 4TH GAME INTERNATIONAL SCIENCE PANEL MEETING

Kenji Nakamura
Institute for Hydrospheric-Atmospheric Sciences
Nagoya Univesity

nakamura@ihas.nagoya-u.ac.jp

The GAME international conference was held about once in two years. This year (1999) the conference was jointly held as: the Third International Scientific Conference on the Global Energy and Water Cycle jointly with the Fourth Study Conference on GEWEX Asian Monsoon Experiment. The conference was held for 16-19 June at Beijing, China.

The fourth GAME International Science Panel Meeting (GISP) was held from 14 to 15 June, 1999 at the Chinese Meteorological Administration, Beijing, China (CMA), with kind supports of CMA, National Space Development Agency of Japan (NASDA) and WCRP. GISP was just before the Fourth GEWEX International Conference at the same place. Twenty three GISP members or representatives and forty two observers/experts from 13 countries participated.

After the opening addresses from Prof. T. Yasunari, Chairperson of GISP, Prof. Hong Yan, vice-administrator of CMA, Mr. Sam Benedict, WCRP office, the panel started. First, current status international activities closely related to GAME, such as GEWEX/WCRP and GHP were presented. After those, typical observation results of each component of GAME and related projects are introduced. Typical results include sensible and latent heat exchange between land and atmosphere in various regions.

GAME Data Management is one of the key for this kind of project. Mr. Takahashi, MRI showed the guideline of the data exchange for confirmation. The

importance of data availability is recognized well in the GAME related communities, and many talks were on the schedule of the data release. Basically, we do not have any serious problem in the data exchange policy.

Future plan of GAME is one of the big subjects of this GISP. Several continuation proposals, for example, extended observation plan for HUBEX and Japan's Frontier Observation System for Global Change, were presented. Coordinated Enhanced Observing Period (CEOP) was proposed by Prof. T. Koike and the importance of the CEOP was recognized and recommendation was adopted.

In the wrap up session, future schedule, such as, next GISP and GAME International Conference was proposed. The former is tentatively scheduled in June 2000 in Tokyo before or after the Western Pacific Geophysical Union Meeting. The latter is somewhere in 2001.

GAME MEETINGS SCHEDULE

6-7 March 2000
2000 Workshop on GAME-T in Thailand
Pechaburi, Thailand
Registration for presentation dead line: 8 Feburary 2000. For Information, contact Prof. Taikan Oki, Institute of Industrial Science, University of Tokyo, 4-6-1 Komaba, Meguro-ku, Tokyo 153-8505, Japan, e-mail: taikan@iis.u-tokyo.ac.jp

End of May 2000
The 2nd International Workshop on the Hydro-meteorology in the Tibetan Plateau - hosted by TIPEX and GAME-Tibet -
Lijang, Yunnan Province, China
For information, contact Dr.Toshio Koike, Department of Civil Engineering, University of Tokyo, Bunkyo-ku, Tokyo 113-8656, Japan, e-mail: tkoike@hydra.t.u-tokyo.ac.jp

26-27 June 2000
The 5th GAME International Science Panel Meeting
Tokyo, Japan
For information, contact the GAME International Project Office, Institute for Hydrospheric-Atmospheric Sciences, Nagoya University, Furocho, Chikusaku, Nagoya 464-8601, Japan, e-mail: gio@ihas.nagoya-u.ac.jp

March 2001, planned.
2001 Workshop on GAME-T in Thailand
For Information, contact Prof. Taikan Oki, Institute of Industrial Science, University of Tokyo, 4-6-1 Komaba, Meguro-ku, Tokyo 153-8505, Japan, e-mail: taikan@iis.u-tokyo.ac.jp

Fall 2001
The Fifth International Study Conference on GEWEX in Asia and GAME
For information, contact the GAME International Project Office, Institute for Hydrospheric-Atmospheric Sciences, Nagoya University, Furocho, Chikusaku, Nagoya 464-8601, Japan, E-mail: gio@ihas.nagoya-u.ac.jp

GAME-related WWW sites

GAME: http://www.ihas.nagoya-u.ac.jp/game/index.html
GAME-T: http://hydro.iis.u-tokyo.ac.jp/Game/game-T.html
GAME-HUBEX: http://www.hubex.pku.edu.cn
GAME-Tibet: http://monsoon.nagaokaut.ac.jp/tibet/
GAME-Siberia: http://www.ihas.nagoya-u.ac.jp/game/siberia/index.html
GAME-AAN: http://www.suiri.tsukuba.ac.jp/Project/aan/aan.html
GAIN: http://gain-hub.mri-jma.go.jp/

GAME Letter
Published by the GAME International Project Office
Prof. Kenji Nakamura

Institute for Hydrospheric-Atmospheric Sciences
Nagoya University
Furocho, Chikusaku, Nagoya 464-8601, Japan
Phone: +81-52-789-5439, Fax: +81-52-789-3436
E-mail: gio@ihas.nagoya-u.ac.jp