A Comparative study of seasonal variation of surface heat flux in Asian Monsoon region. (Session 6: Large Scale Energy and Water Balances studies)

A Comparative study of seasonal variation of surface heat flux in Asian Monsoon region.

Shin Miyazaki[1], Osamu Tsukamoto[2], Motomu Toda[3], Nobuhito Ohte[4], Kenji Tanak[5], Ichiro Kaihotsu[6], Tadashi Miyamoto[7] and Tetsuzo Yasunari[8]

[1]*Terrestrial Environment Research Center, University of Tsukuba, 1-1-1 Tennodai, Tsukuba, Ibaraki, Japan 305-8577, e-mail: shin@erc2.suiri.tsukuba.ac.jp*
[2]*Faculty of Sciences, Okayama University, Japan,* [3]Forestry and Forest Products Research Institute,
[4]Graduate School of Agriculture, Kyoto University, [5]*Water Resources Research Center, DPRI, Kyoto Univ.*
[6]*Hiroshima University, Japan,* [7]*Master's Program in Environmental Science, University of Tsukuba,*
[8]*Institute of Geoscience, University of Tsukuba, Japan*

1. Introduction

Since 1997, the GAME-AAN (GAME Asian Automatic weather station Network) Project set 14 AWSs as shown in Fig1. The purpose of this project is to monitor the surface energy fluxes along the meridional as well as longitudinal transects in monsoon Asia. Also it was aimed to clarify the seasonal changes of surface fluxes with the variation of surface conditions in the different climate (Miyazaki et al., 2001). The long-term monitoring of surface fluxes and surface conditions are very important for unraveling the physical process of climate change. In this study we focus the comparison of seasonal variation of surface heat flux in monsoon Asia to remedy the interaction between land-surface and atmosphere.

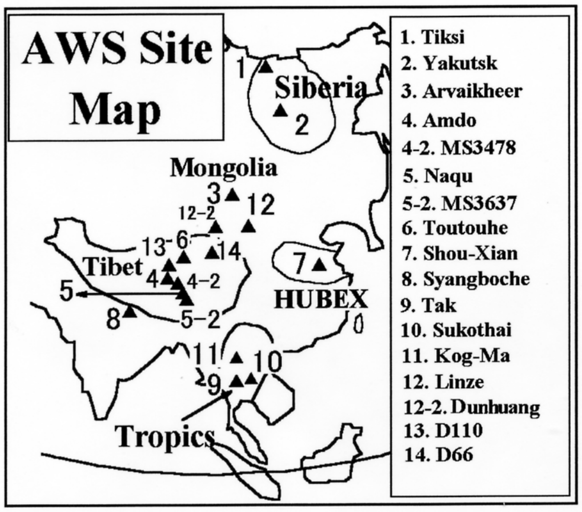


Fig.1 Location map of GAME-AAN sites.

2. Observation sites and methods

The observation sites using this abstracts are Arvaikheer, glass-land in Mongolia (46.16N, 102.47E, alt. 1812m), MS3478, glass-land over permafrost, in Tibet, China (31.9N, 91.7E, alt. 4765m), Shouxian, paddy field in China (32.58N, 116.77E, alt. 23m), and Tak, mixed lands in Thailand (16.88N, 99.15E altitude 121m). At all station we used the Portable Automated Mesonet III (PAM III, Militzer *et al*, 1995) developed at the National Center for Atmospheric Research (NCAR) in U.S. PAM III station uses a 3D sonic anemometer (GILL R3A) and a hygrothermometer (Vaisala 50Y) to determine surface turbulent fluxes of momentum, heat and water vapor by applying an eddy correlation technique and the bandpass covariance method (Horst and Oncley, 1995; Horst et al, 1997; Aoki et al., 1998). Also we applied the Bowen ratio method to calculate the sensible heat flux and latent heat flux.

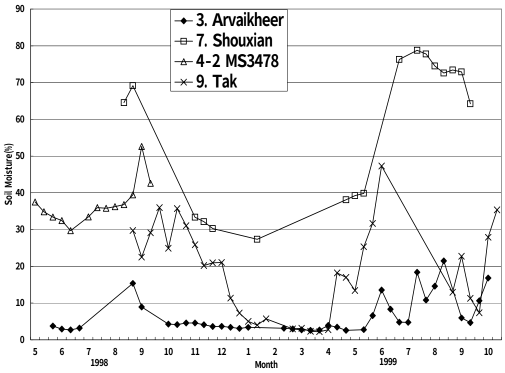
3. Preliminary results

Figure 2 shows that the time series of 10days mean values of soil moisture at the near surface of four AAN sites. As the surface is paddy filed at Shouxian, the soil moisture was always high. It was about 30% to 40% in winter and about 70% to 80% in summer, which implies that it was almost saturated soil. At MS3478 the soil moisture was about 30% to 50% and there was no remarkable drying period as shown at Tak and Arvaikhher. The soil moisture at Tak attained more than 30% in rainy season but less than 10% in dry season.

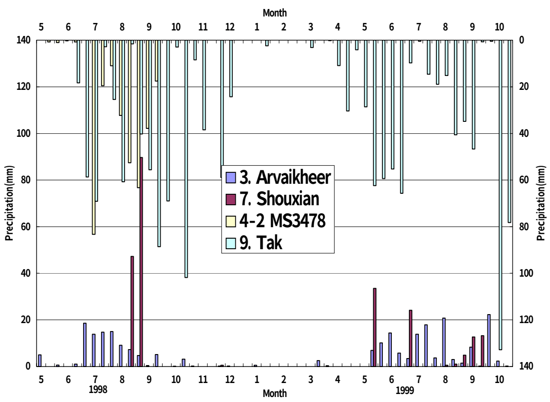
The precipitation at each site is shown in Fig. 3. We'd like to note that the data at Shouxian has many missing data and the data at the Tibet is limited only from May to September of 1998.

The rainy season of Thailand has started in April and it has ended in November. In Mongolia, the most of annual rainfall was occurred from June to August. There was good relation between precipitation amount and soil moisture both at Tak and Arvaikheer.

Fig.2 Time series of the 10 days mean soil



moisture at Arvaikheer-Mongolia, Shouxian-China, MS3478-Tibet, and



Tak-Thailand.

Fig.3 Time series of the 10 days accumurated precipitation at Arvaikheer-Mongolia, Shouxian-China (lower bars), MS3478-Tibet and Tak-Thailand (upper bars).

Figure 4 shows that the time series of 10 days mean values of the net radiation. The net radiation decreases, as the latitude became high. Only in Mongolia the net radiation become much smaller than other sites. It may imply that the albedo was very high due to the snow cover. (figure was not shown.)

The time series of the 10days mean values of Evaporative fraction at each sites was shown in Fig. 5. At the Shouxian the evaporative fraction was high all the year round, which may imply that the evaporation was very high due to the very wet surface as shown in Fig. 2. On the other hand, the evaporative fraction at Arvaikheer was high only in summer but low in winter, which may be related to the seasonal variation of soil moisture and precipitation as shown in Fig.2 and Fig. 3. Also It will be related to the large temperature difference between summer and winter as the evaporation depends the temperature. Although the evaporative fraction at Tak was large and small in rainy season and dry season, respectively, it was larger than its in Mongolia. At MS3478 the evaporative fraction increased rapidly from the pre-monsoon period to monsoon period.

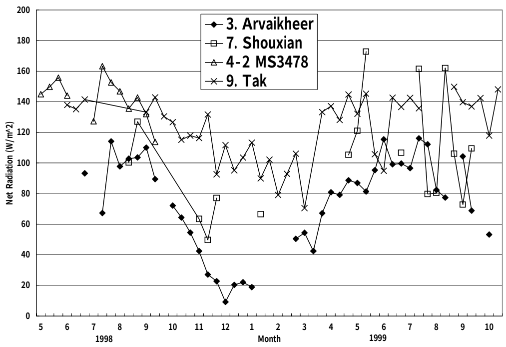
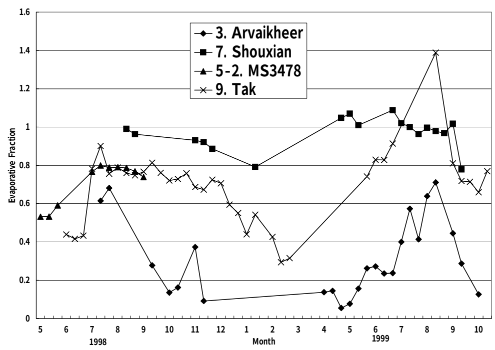


Fig. 4 Time series of the 10 days mean net radiation at Arvaikheer-Mongolia, Shouxian-China, MS3478-Tibet, and Tak in



Thailand.

Fig. 5 Time series of the 10 days mean Evaporative fraction at Arvaikheer-Mongolia, Shouxian-China, MS3478-Tibet, and Tak-Thailand.

4. Future works

In this study we only showed 4 sites of AAN in semi-arid, temperate, mountainous, and tropical climate in limited short period due to the availability of data. More longer period and the sites located other climate region should be studied in the future. Also we only showed the relation between soil moisture and energy flux. The influence of vegetation to the energy fluxes has to be studied in the next step.

References

Aoki, M., T. Chimura, K. Ishii, I. Kaihotsu, T. Kurauchi, K. Mushiake, T. Nakegawa, N. Ohte, P. Polsan, S. Semmer, M. Sugita, K. Tanaka, O. Tsukamoto and T. Yasunari, 1998: Evaluation of surface fluxes over paddy field in tropical environment: Some findings from a preliminary observation of GAME., *J. Japan Soc. Hydrol. and Water Resour.* 11 (1), 39-60.

Horst, T. W., S.P. Oncley (1995): Flux-PAM measurement of scalar flux using cospectral similarity. Proc. of the 9th AMS Symposium on Meteorological Measurements and Instrumentation, Charlotte,NC,495-500

Horst, T.W., S.P. Oncley, and S.R. Semmer (1997): measurement of water vapor fluxes using capacitance RH sensors and cospectral similarity. Proc. of the 12th AMS Symposium on Boundary Layers and Turbulence, 360-361.

Militzer, J.M., M.C., Michaelis, S.R. Semmer, K.S. Norris, H.W. Horst, S.P. Oncley, A.C. Delany and F.V. Brock (1995): Development of the prototype PAMIII/Flux-PAM surface meteorological station, Proc. of the 9th AMS Symposium on Meteorological Measurements and Instrumentation, Charlotte, NC, 490-494.

Miyazaki, S., M. Sugita, and T. Yasunari (2001) The example of flux observation in some projects (GAME-AAN), Climatological Research Note (in press).