Diurnal vairation of GPS Precipitable Water Vapor over Thailand during GAME−T IOP of 1998

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This study explores the diurnal variation of precipitable water vapor estimated from GPS data (GPS-PWV) with high time resolution at Bangkok and Chiang Mai during the GAME-Tropics Intensive Observation Period (IOP) of 1998. GPS−PWV at one−hour interval are calculated from the total zenith atmospheric delay with the surface temperature and pressure.

There exist diurnal variations of GPS−PWV at Bangkok and Chiang Mai sites in the premonsoon period from mid April to early May, but GPS−PWV at Bangkok reaches the maximum vales at around early morning while that at Chiang Mai reaches that at around evening. Such a reverse phase may be due to the geographical location. PWV may affect the see-breeze induced water vapor fluxes at Bangkok and the mountain-valley induced local circulation at Chiang Mai. Diurnal variations of the specific humidity at the surface level do not shows apparent consistency with those of GPS−PWV.

Key Words : *precipitable water, diurnal variation, GPS*

1. Introduction

Diurnal variations are dominant in the Tropics and many studies are dedicated to this topics such as precipitation[1)] and deep convection[2)]

Precipitable water is a fundamental variable but its diurnal variation has not yet been investigated because precipitable water is observed routinely twice a day at best.

New instrument to monitor it, Global Positioning System, is emerging recently and it can provides its data at the interval of one hour. Diurnal variation of precipitable water at Tibetan Plateau was studied and was affected by the local circulation induced by the mountain−valley topography[3)].

In the present study, diurnal variation of precipitable water in Thailand is investigated.

2. Data and Analysis

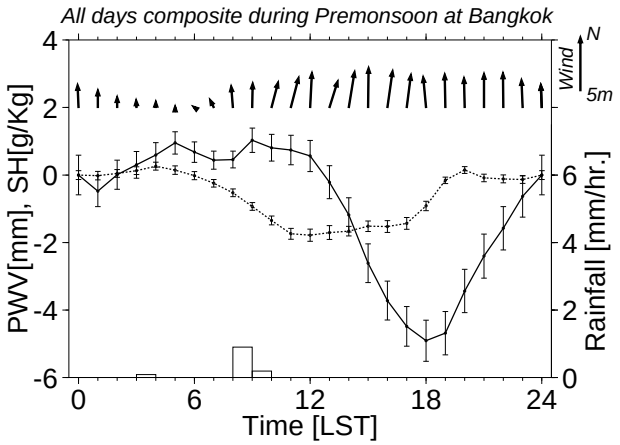
GPS data recording systems were installed in five sites at wide area in Thailand. These sites are selected from upper air observatories of Thai Meteorological Department(TMD), Chiang Mai(Code:CHMI), Nong Khai(NNKI), Si Samrong(SISM), Bangkok(BNKK), Ubon Ratchatani(UBRT), and Phuket(PHKT) in March of 1998.

The GPS data were processed with the GIPSY-OASIS II ver. 2.5.2 baseline software[4)]. Zenith tropospheric delay (ZTD) was estimated every five minutes and its values were averaged for every thirty minutes[5)]. Surface meteorological variables are needed for the retrieval of precipitable water from ZTD. They at the hourly resolution were provided from TMD.

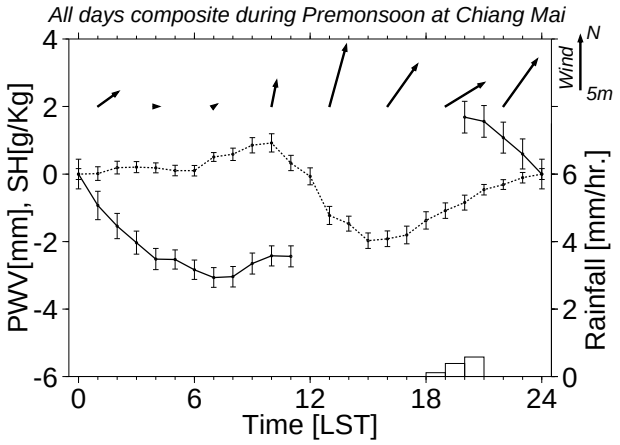
3. Results

Figure 1 shows the diurnal variation of precipitable water, rainfall, specific humidity and wind vector at Bangkok and Chiang Mai during the Premonsoon period of 1998.

There exist diurnal variations of GPS−PWV at both sites in the premonsoon period from mid April to early May, but GPS−PWV at Bangkok reaches the maximum vales at around early morning while that at



(a) Bangkok



(b) Chiang Mai

Fig.–1 Diurnal variation of precipitable water during the premonsoon season of 1998 with those of rainfall, wind vector and specific humidity at (a) Bangkok and (b) Chiang Mai.

Chiang Mai reaches that at around evening. Such a reverse phase may be due to the geographical location. PWV may affect the see-breeze induced water vapor fluxes at Bangkok and the mountain-valley induced local circulation at Chiang Mai. Diurnal variations of the specific humidity at the surface level do not shows apparent consistency with those of GPS−PWV. In order to verify the existence of the opposite phase in Thailand, GAME-Reanalysis data (ver. 2.1) are used. Its spatio-temporal resolution is 1.25°×1.25° in space and six hours in time. Fig.2 shows the diurnal variation of precipitable water during the premonsoon period over Indo−China Peninsula. Precipitable water at Chiang Mai (18.7°N,99°E) reaches the maximum at 01LST and the minimum at 13LST, while that at Bangkok (13.7°N,100°E) reaches the maximum at 19LST and the minimum at 13LST. This supports the results of Fig.1, but the phase between Fig.1 and Fig.2 at each site is different. This is possibly due to the coarse resolution of GAME-Reanalysis.

The amplitude of GPS−PWV during the onset period from mid May to mid June, reduced about a half of that during the premonsoon period at both sites. GPS−PWV at both sites has a maximum amplitude in the morning and in the evening. Such a double peak are also found in the deep convection over seas such as ITCZ and SPCZ. Hence the double peak suggests the the peak of the other convection such as the shallow one at the different hour. The decrease of GPS−PWV in the evening is consistent with the precipitation events and it could be considered as the conversion of water vapor to the cloud through the convection and finally to the precipitation.

Rainy days and no rainy days are decomposited and the diurnal variations are also examined. The double peak appear in both composite figures but the amplitude of rainy days is larger than that of the no rainy days. This results suggest the double peak occurs irrespective of the precipitation events, and therefore the double PWV peak might link with the double peak of the convection.

In the late monsoon period, the basic feature of the diurnal variation at both points are similar to those in the early monsoon period. No unique characteristics is found in this period, which suggests that the effect of the land surface on the diurnal variation differ so much in the two periods.

4. Summary

The present study reveals the characteristics of the diurnal variation of PWV at Bangkok and Chiang Mai, and they have different phases in premonsoon period while they are the same in early and mature monsoon seasons. Valley-induced local circulation might contribute to this phenomena but it is not so much significant because the diurnal variation of wind vectors is not consistent with it. Further an intensive observation and a numerical experiment is needed to clarify the mechanism responsible for it.

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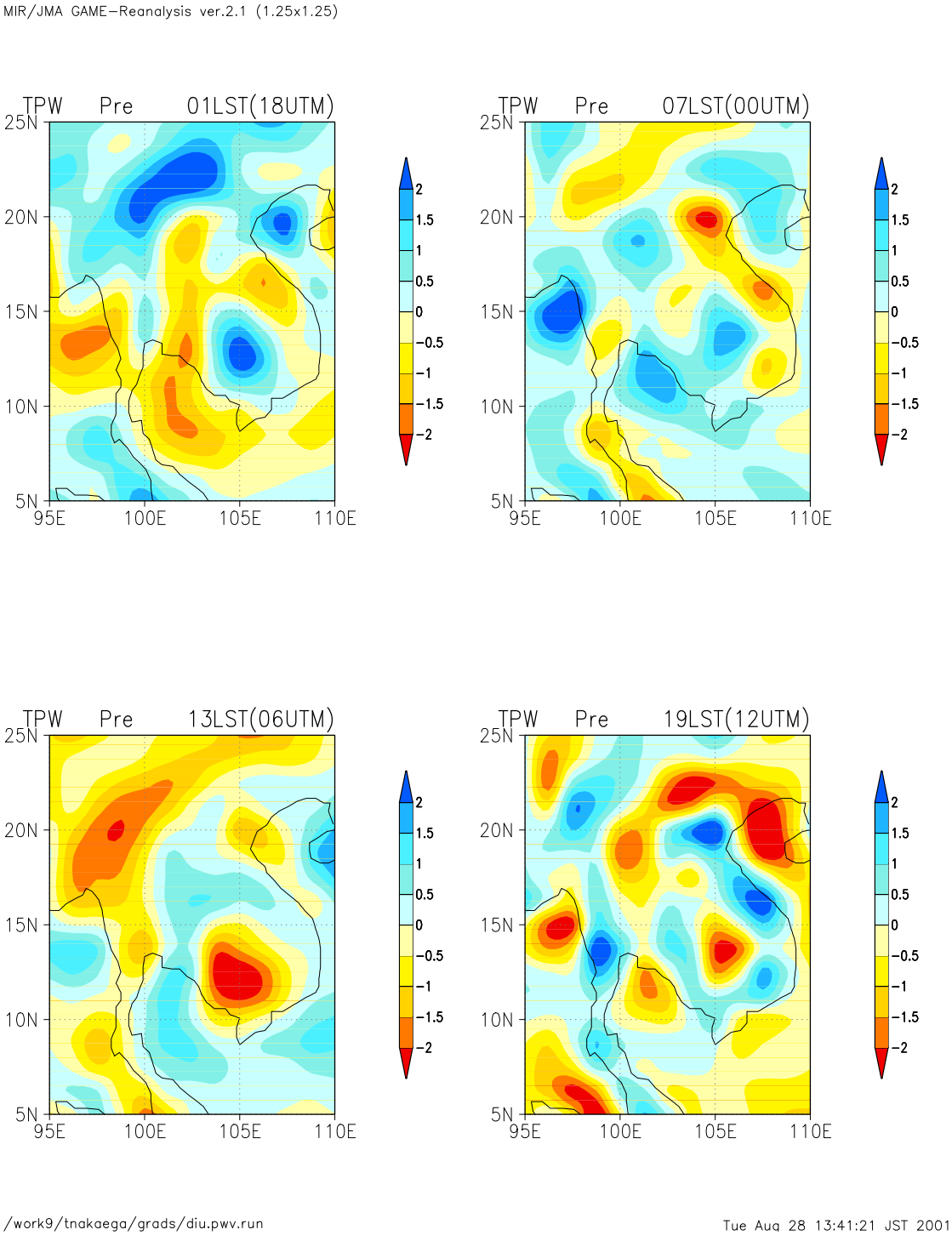

Fig.−2 Same as Fig.1 but over Indo−china Peninsula. Upper left:01LST, upper right 07LST, lower left 13LST, and lower right 19LST.

scientific grants. Hourly surface meteorological data during intensive observation periods are specially prepared for this study by TMD. Many staffs in National Research Council of Thailand and Royal Irrigation Department, help our activity enormously. We wish to thank all for arrangement of our activities.

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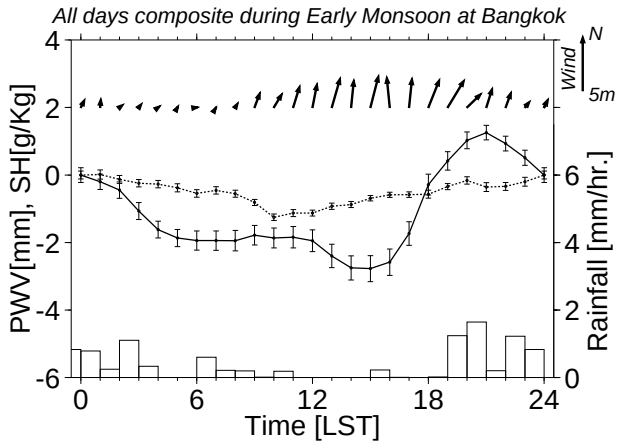
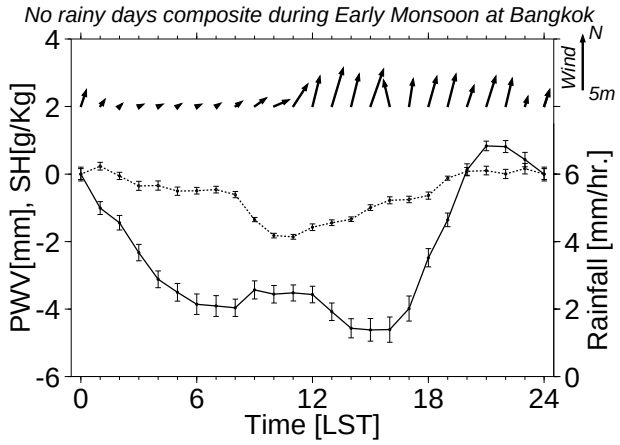
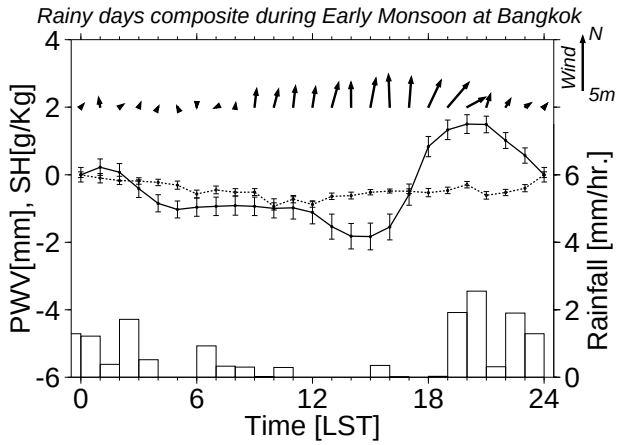


(1) All Days Composite

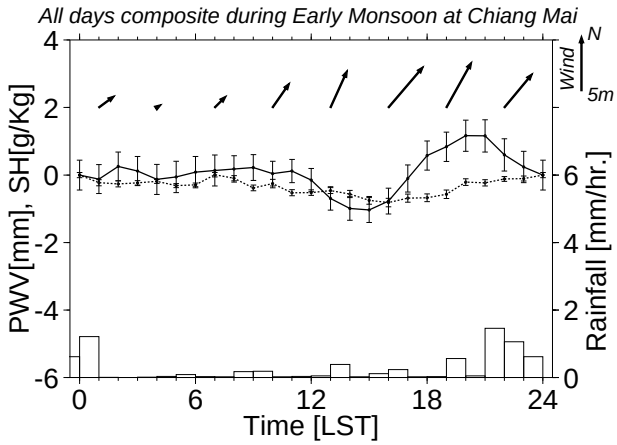


(2) No Rainy Days Composite

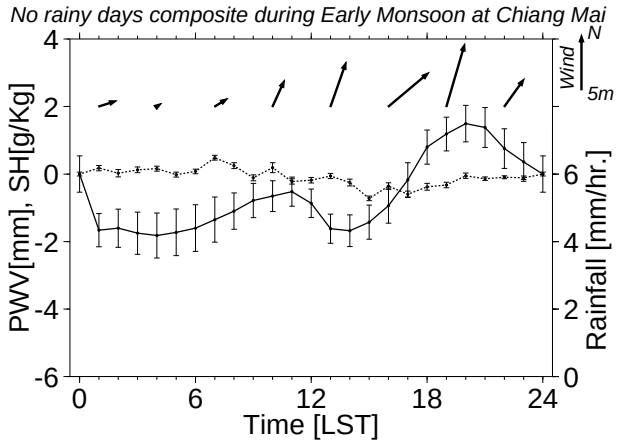


(3) Rainy Days Composite

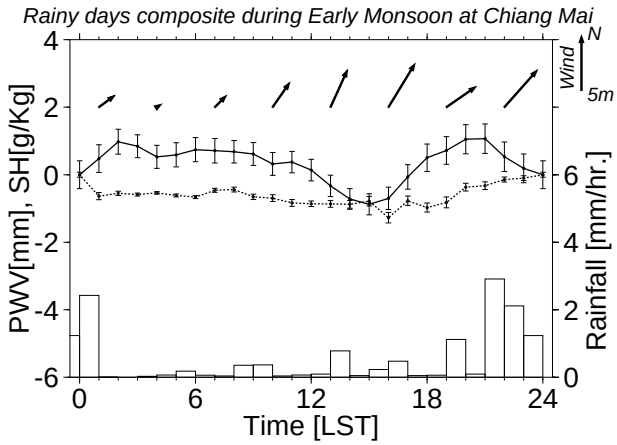
Fig.–3 Same as Fig.1 but during early monsoon period of 1998 at Bangkok.



(1) All Days Composite



(2) No Rainy Days Composite



(3) Rainy Days Composite

Fig.–4 Same as Fig.1 but during early monsoon period of 1998 at Chaig Mai.

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