Assessing the seasonal and inter-annual variability of evapotranspiration based on the big-leaf model in a lowland tropical rainforest, Sarawak, Malaysia

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Tropical rainforests are important latent energy source having a strong influence on local hydrology. Thus, measurements and modeling of evapotranspiration in a lowland tropical rainforest in Southeast Asia are essential for quantitative predictions of the impact of climate change on local hydrology. Our previous study reveled the small seasonality of evapotranspiration in a lowland tropical rainforest in Lambir Hills National Park based on the numerical model for daily evapotranspiration and the hydrologic data set for single year (Kumagai et al., 2005). However, the region around the park has been characterized by the occurrence of a large inter-annual variation in rainfall. It can be thought that the inter-annual variations in rainfall and the other micro-meteorological elements might impact on the evapotranspiration in this park. In addition, evapotranspiration processes, which consist mainly of wet-canopy evaporation and dry-canopy transpiration, are quite different depending on whether canopy is wet or dry. In this park, rain events with short duration occur frequently (Kuraji et al., 2001), thus, canopy wetness condition drastically changes within a day (Kume et al., 2005). This suggest that evapotranspiration in this park should be assessed by the model that can consider wet-canopy evaporation and dry-canopy transpiration separately with hourly time-step.

This study was undertaken to assess the seasonal and inter-annual variability of evapotranspiration in a lowland tropical rainforest, in Lambir Hills National Park. To this aim, Penman-Monteith type of the big-leaf model for evapotranspiration was formulated using the different functions of wet and dry canopy with hourly time-step. This model was validated with the canopy transpiration by eddy covariance method, the individual tree-transpiration by sap flow measurements, the rainfall interception based on throughfall and stemflow measurements, and the general micro-meteorological measurements above the canopy, which commenced in January 2000 (Fig. 1).

In this model, three unknown parameters were determined as follows. Surface conductance (*Gs*), which represents physiological control of transpiration, was formulated based on the relationships between estimated *Gs* by eddy covariance method and the micro-meteorological elements such as solar radiation and vapor pressure deficit (Kumagai et al., 2004). Aerodynamic conductance (*Ga*), which represents environmental control of water vapor transport from vegetation, was determined by the wind profile measurements. Rainfall storage capacity (*Sc*) on the canopy was determined by an original method based on sap flow measurements. The accuracy of evapotranspiration estimated by the formulated model in this study were confirmed by comparing with the total amount of daily canopy transpiration by eddy covariance method, the diurnal courses of tree transpiration (Kume et al., 2005), and the total amount of rainfall interception for three years (Manfroi et al., 2005). By using the simulated evapotranspiration and the micro-meteorological elements (Fig. 1) for 5 years in this park, the sources of seasonal and inter-annual variability of evapotranspiration were examined.

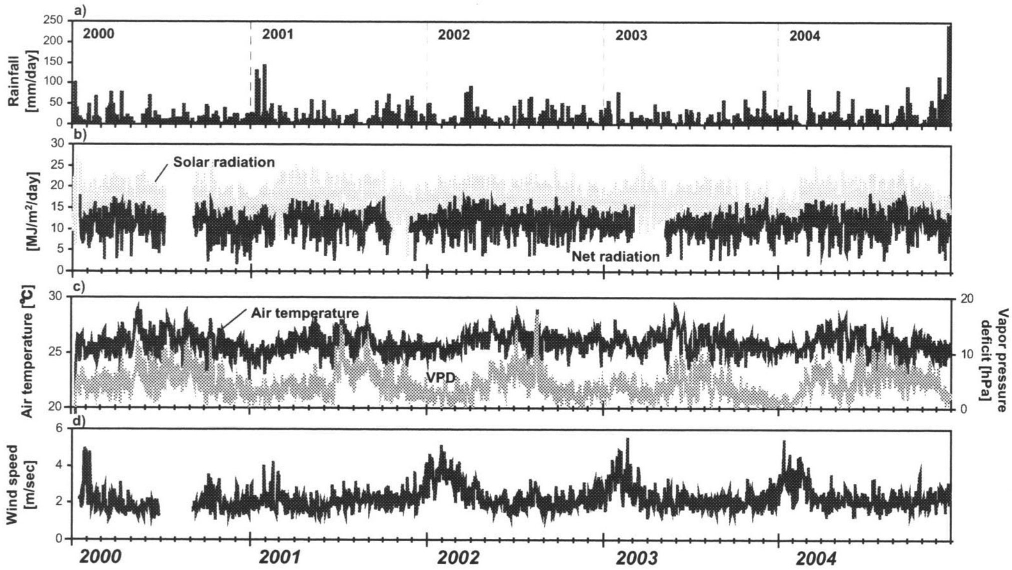

Fig. 1 Gap-filled time series daily micro-meteorological elements of a) rainfall, b) solar radiation and net radiation, c) air temperature and vapor pressure deficit (VPD), d) wind speed measured for 5 years in Lanbir Hills National Park.

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