Water and carbon budget of a lowland tropical rainforest in Sarawak, Malaysia

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Global environmental fluctuations affect the forest ecosystem through disturbances that work as triggers for such biological processes like flowering and reproduction. In turn the carbon and water cycles as consequences of the forest physiology and dynamics feed their effects back to the atmosphere. A research program "Research and observation on the effect of rainfall variability on water cycle and ecosystem in tropical forest" is carried out to understand the mechanisms of atmosphere-ecosphere interaction in relation to severe drought occurred during El nino condition, succeeded to a research item, "Gaseous exchange in the tropical forest canopy", in the previous joint research project between Forest Department Sarawak and Japan Science and Technology Agency entitled "Research and Observation on the mechanisms of atmosphere-ecosphere interaction in tropical rainforest canopy" which has been conducted since 1999, reveals basic features on canopy dynamics and gas exchange in and above the canopy and terminated on November 2003.

This paper presents the results of water and carbon budget of a lowland tropical rainforest observed in Lambir Hills National Park (4° 12'N, 114° 02'E) , Sarawak, Malaysia. A 4ha experimental plot at an altitude of 200m, gridded into 400 subplots or quadrats of 10m×10m, was used in this project. An 80m tall (at the base pf the gondola) canopy crane with a 75m long rotating jib was situated in the center of this plot to access to the upper canopy. Observation stages at four levels (23.5,38.5, 59.0 and 75.5m above the ground) accessible by elevator were also installed. The 59.0m high stage was devoted to eddy covariance flux measurements. The subplots or quadrats were used for in-canopy micro-meteorological measurements, throughfall and stemflow measurements. The canopy height surrounding the crane is about 40m but the height of the emergent treetops can reach up to 50m.

Results from measurements of evapotranspiration and evaporation of rainfall interception by canopy, annual evapotranspiration of this forest is estimated to be 1400mm. The annual evapotranspiration, transpiration and interception in 2001-2002 estimated by Kumagai et al. (2005) were 1550mm, 1200mm and 350mm, respectively. However, reanalysis on interception loss, Manfroi et al.(submitted) concluded annual evaporation of rainfall interception by canopy were about 200mm based on precise 4ha plot estimation. While there were some dry conditions in the observation period that could have affected transpiration rate, the measured transpiration (evapotranspiration from dry canopy) conformed with equilibrium evaporation and annual transpiration value was on the highest boundary of their range for tropical forest. Our results imply that the annual dynamics of the latent heat flux for this tropical forest are under more humid conditions than for Amazonian tropical forests.

Results from measurement of CO_2 fluxes using eddy covariance method over one and half years, annual gross primary production (GPP), ecosystem respiration and net ecosystem exchange (NEE) were estimated to be 29-31tC $ha^{-1}y^{-1}$, 27-29tC $ha^{-1}y^{-1}$ and -4.83tC $ha^{-1}y^{-1}$ (sink), respectively (Saito et al., 2005). The value of NEE, however, might have been

underestimated, because of incorrect measurements of night-time NEE under stable conditions. The NEE corrected was estimated to be 0.75tC $ha^{-1}y^{-1}$(source), adopted night-time NEE inferred by the interception of light response curve. Estimated annual NEE was not comparable with that reported to be –2.2tC $ha^{-1}y^{-1}$ to –1.05tC $ha^{-1}y^{-1}$ for Amazonian tropical rainforest (Grace et al., 1995).

Further continuous monitoring research is now required, as the effects of drought on water and carbon budget in Lambir Forest still remain uncertain.

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