EVAPORATION FROM A PINE FOREST*

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(received March 5, 1987)

ABSTRACT

Although intensive observations of forest evaporation for the past one or two decades revealed many interesting phenomena on forest evaporation, they were often based on the measurements on "typical" days, or clear summer days. In the present study obsevations of evaporation, interception, and transpiration activities were conducted at a pine forest over three years. Also observed was seasonal variation in amount of foliage, wetness of the canopy and soil water content. Analyses of these data with emphasis on seasonal variation revealed changes in wet- and dry-canopy evaporation rates and their mechanisms. The results are summarized as follows:

(1) The evaporation rate of wet canopy was usually within 0.3 mm/h during a daytime and 0.16–0.18 mm/h during a nighttime through the year. Evaporation rate of dry canopy, on the other hand, changed seasonally with highest rate of 0.1–0.8 mm/h in summer and lowest rate of 0.1–0.3 mm/h in winter. The integration of hourly evaporation rate of dry canopy over a daytime amounted to the smallest value of 0–1.5 mm in January and the biggest value of 5–5.5 mm in August.

(2) Observations with the heat pulse method showed that the origin of evaporation of wet canopy was intercepted rainfall and thus canopy resistance went to zero. Therefore evaporation rate can be determined solely by meteorological factors. Observations showed that both vapor pressure deficit and available energy stayed constant through the year in wet-canopy condition unlike in dry-canopy condition. This situation led to the lack of seasonal variation in wet-canopy evaporation rate.

(3) When canopy is dry, transpiration is controlled through canopy resistance. Canopy resistance stayed almost constant before early afternoon and then rapidly increased in the afternoon. This pattern of the diurnal variation was consistent through the year; magnitude of the resistance, however, differed seasonally. The seasonal variation can be explained with two mechanisms: changes in leaf area index and stomatal aperture. Leaf area index decreased with leaf fall from the maximum value of 4.0 in July to the minimum value of 1.68 in the middle of July and then increased with foliation. Stomatal aperture is usually caused by the two factors: soil water deficit and changes in meteorological elements. However, soil water deficit proved not to cause stomatal closure in the study area. As for the meteorological elements, vapor pressure deficit had the highest correlation coefficient for $Rn > 80$ W/m^2. Regression analysis between stomatal resistance and vapor pressure deficit for four seasons showed that the minimum stomatal resistance was at 100–150 s/m and that slopes of the regression equation changed seasonally. The cause of the variations was suggested as changes in leaf age and air temperature.

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* A dessertation submitted in partial fulfillment of the requirements for the Doctor of Science to Doctoral Program in Geoscience, University of Tsukuba

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