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Water and energy fluxes above an Eucalyptus plantation in Brazil: environmental control and comparison with two eucalypt plantations in Congo

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Tropical eucalypt plantations provide an increasing share of the global wood supply. High yields on weathered tropical soils are one of the main reasons for their success. However, there are often suspected of high water-use and their productivity may often be constrained by water availability. Our main objectives in this study were: 1) to quantify water-use (actual evapotranspiration, AET) by a 5-6 yr-old eucalypt plantation in Southeast Brazil; 2) to investigate the main environmental factors controlling canopy stomatal conductance and the partitioning of available energy between latent (LE) and sensible heat (H) fluxes; 3) to compare the AET measured in this highly productive plantation to the AET measured in two eucalypt plantations in Congo and identify the main factors that explained the observed differences in water-use. AET measured by eddy-covariance in the Brazilian plantation (≈ 1300 mm/yr) represented nearly all of the annual rainfall (≈ 1380 mm/yr). Most of the available energy (82%) was used for AET. The bowen ratio (H/LE) remained very low most of the year, but increased sharply when the “effective” relative extractable water content (REW) in the root zone (0-10 m) decreased below a threshold value. The diurnal and seasonal variability in canopy stomatal conductance was accurately explained by a simple model accounting for the effects of VPD, REW, LAI, and incoming PAR. Despite similar annual rainfall (≈ 1200 mm/yr), AET measured in the less productive Eucalypt plantations in Congo was low (≈ 700 mm/yr) compared to that measured in Brazil. These differences were mostly explained by differences in net radiation (≈ 2740 MJ/m²/yr in Congo versus ≈ 3830 in Brazil), site fertility and LAI (1.4 and 2.4 for the two clones in Congo versus 3.2 in Brazil). In Brazil, AET decreased sharply after clear-cutting and replanting allowing deep drainage (below 10 m) a few months after clear-cutting.

Key Words

Eucalypt plantation, Actual evapotranspiration, eddy-covariance, canopy stomatal conductance