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Water Balance of an Australian Subtropical Rainforest at Altitude: the Ecological and Physiological Significance of Intercepted Cloud and Fog

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Abstract

A water balance study of a small subtropical rainforest catchment (10 ha, 1000 m altitude) was conducted at Gambubal State Forest, near the headwaters of the Condamine River, 200 km south-west of Brisbane, south-eastern Queensland. Mean annual rainfall of the site is approximately 1125 mm, but is variable and often less than 900 mm. Tree transpiration rates are low and depletion of the large soil moisture reserves enables extraction for lengthy periods of time, permitting survival during extended dry seasons (May–November). Fog deposition to the forest provides the equivalent of an additional 40% of rainfall to the site as measured using a conventional rain gauge. A frequently wet canopy results in reduced transpiration rates and direct foliar absorption of moisture alleviates water deficits of the upper crown leaves and branches during the dry season. These features of this vegetation type may enable long-term survival at what could be considered to be a marginal rainforest site.

Introduction

Given the generally arid and variable climate of Australia, it is important to have an understanding of the hydrological regime of major vegetation types, as this will help elucidate the role of vegetation in surface energy and water balances. Australian rainforests are unique in that their distribution covers a wide climatic range, and they are often subjected to prolonged periods of low water availability (Doley *et al.* 1987, 1988), unlike many of the equatorial rainforests. This feature of the Australian climate makes the study of tropical (and subtropical) Australian rainforests particularly significant as they differ from equatorial tropical regions, where most research on tropical forest–atmosphere exchange has been conducted (Shuttleworth 1988).

As water vapour and heat transfer between forests and the atmosphere are intimately coupled, water balance can be considered to be an ecologically sensitive index of climate (Lal 1987; Frank and Inouye 1994) as it is an integrated measure of energy and water fluxes associated with many basic ecological processes. Forest water fluxes provide the transport medium for biogeochemical cycles and the two are closely linked. Water balance studies in Australian forests have focused on natural eucalypt forests and woodlands (Holmes and Colville 1970; Leuning and Attiwill 1978; Dunin and Mackay 1982; Sharma 1984; Denmead *et al.* 1993), as a major fraction of the continent's streamflow is derived from eucalypt forest catchments (Sharma 1984), and there are few data available on the hydrological characteristics of Australian rainforests (Gilmour 1975).

Rainfall dominates the moisture input to rainforests, but it is recognised that cloud and fog may be important sources of water for some forests occurring at altitude (Zadroga 1981). The

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