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Quantifying the Heterogeneity of Transpiration Fluxes from Tree Crowns: Results from a Case Study on *Eucalyptus* Trees in the West-Australian Wheat-Belt

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Abstract

Trees and shrubs often grow in irregular patterns as opposed to uniform field crops. Fluxes of heat and mass as well as momentum exchange are more difficult to quantify under such conditions and require consideration of intra-canopy processes. A generic model has been constructed to simulate the heterogeneity of transpiration fluxes from non-uniform plant canopies. It was parameterised and tested in a natural *Eucalyptus* forest located in the centre of the West-Australian wheat belt, which is currently heavily affected by soil salinity due to inappropriate land management over the past decades. The general purpose of the study was to understand the water use patterns of the natural vegetation and to use this information to re-design agricultural systems. The model divides the canopy in three-dimensional cells called voxels and simulates their complete energy-balances. It was parameterised with respect to canopy architecture, stomatal response to light, vapour pressure deficit (VPD), leaf temperature and local water stress, as well as aerodynamic transport. Simulations of direct and diffuse radiation fluxes are carried out with a ray-tracing algorithm and canopy surface temperatures were determined by solving the energy-balance equation with the Newton-Raphson algorithm. Model outputs were compared against independent measurements of sap-fluxes using the heat-pulse technique. It produced highly accurate results on a seasonal scale, but initially failed in repeating diurnal measured transpiration. Recent results of branch-level transpiration simulations and corresponding sap-flow measurements will be shown, which were undertaken in the 2006/2007 season and lead to significant increases of the predictive quality of this model. These results suggest that mechanism governing changes of hydraulic tree structure must be considered more closely when simulating the heterogeneity of transpiration fluxes on a short time scale.

Keywords: Energy-balance, *Eucalyptus salmonophloia*, heterogeneity, modelling, plant architecture, plant-water relations, simulation

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