PAPER ID
Session: H31B
Poster Board Number: 0992
Time: 8:00 – 12:00 hs

Calibration of home-made heat dissipation probes for a full rotation of Eucalyptus grandis trees in Brazil

Juan S. D. Rojas; Jean Paul Laclau, Olivier Roupsard, José Luiz Stape, Jacques Ranger, Jean-Pierre Bouillet, Yann Nouvellon*

* yann.nouvellon@cirad.fr

Introduction

Water-use by *Eucalyptus* plantations is likely to reduce stream flows after afforestation of pastures, and to influence the local hydrological cycle. It was studied at the stand-scale by eddy-covariance (EC), and at the tree and stand scales by sap flow measurements using heat dissipation probes (HDPs). Our objectives in this study were: a) to propose an appropriate calibration equation that could be used for *Eucalyptus grandis* trees of any size over a 7 years rotation; 2) to upscale sap flow measurements from the tree to the stand; 3) to compare stand transpiration derived from sap flow measurements to evapotranspiration (ETR) measured by EC for conditions of negligible soil evaporation.

Materials and Methods

The study was carried out in southeast Brazil over the years 2008 and 2009.

Figure 1. Study sites: Sao Paulo State. Brazil

Calibration of HDPs probes (Fig. 2): Direct measurements of water consumption were made on 3 trees in 19, 45, 54 and 72 month-old stands: the trees were cut and kept in situ, standing with the bottom inserted in a water tank (Fig. 3). The volume of water used daily by each tree was measured. Sapflow was also measured on the same trees using HDPs installed in the trunks (Fig. 4). Sapwood area (A) was measured at the end of the experiment.

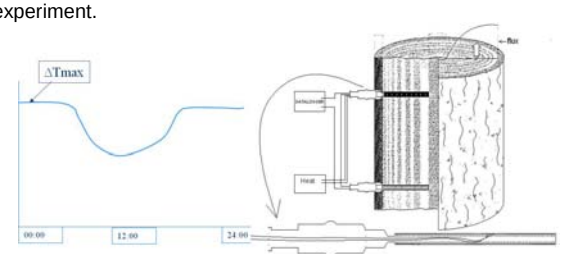

Figure 2. Details of Granier´s probes (sapflow sensor) and the operating principles

Granier's equation (Eq. 1) was calibrated by minimizing the difference between water-consumption observed and estimated on these 12 sampled trees. The original value of the power coefficient of Granier's equation was unchanged, but the value of the other coefficient was estimated.

Validation at the tree scale: After calibration, SF measured with HDPs on 3 trees of different size in 29 and 65 month-old stands were compared with direct measurements made on the same trees.

Validation at the stand level: SF was monitored by HDPs over 8 months on 15 trees selected to cover the range of tree sizes in a 6-year old commercial plantation. Stand transpiration was estimated by weighting the transpiration of individual trees by the proportion of their size-class within the stand, and compared with ETR measured by eddy-covariance during periods when soil evaporation was negligible (low soil water content in the 0-15 cm soil layer).

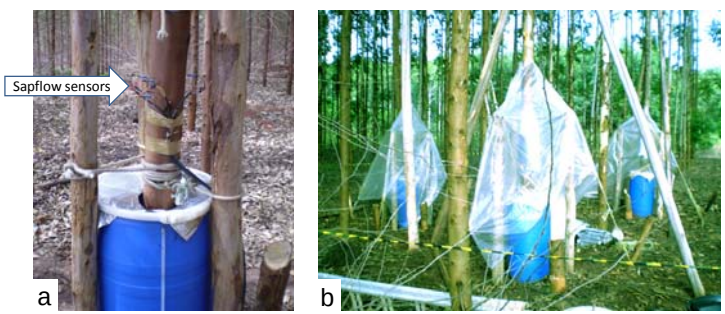

Figure 3. Details of direct measurements of water consumption on cut trees in situ. a) Bottom trunk inside in water tank and b) Overview of three trees being measured.

Figure 4. View of the sapflow sensors placed in the trunk of Eucalyptus trees.

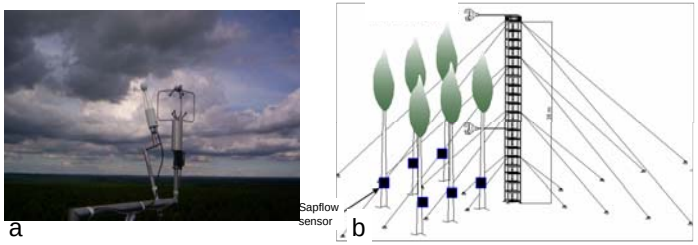

Figure 5. a) Sonic Anemometer and infrared air analyzer. b) Schematic view of eddy covariance method (above canopy) and the sap flow method (below)

Results and Discussion

Results showed that the calibration developed for these home-made probes can be used with great reliability at the tree and stand scales (Figures 6 and 7). The simplicity of this method (and the low cost of sensor preparation) makes it useful to assess the effects of management practices on water consumption by *Eucalyptus* trees.

$$SF = 478.017 * 10^{-6} . k^{1.231} A .. \left(\frac{m^3}{s} \right)$$

K = Thermal factor (Flow index)
SF = Sap flow
A = Sapwood area (m^2)

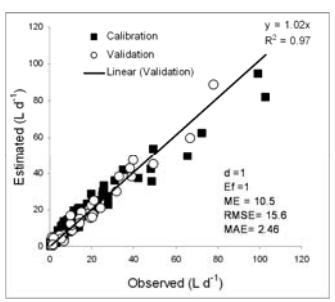

Figure 6. Comparison of estimated and observed values of tree water consumption. Filled squares: calibration data; Open circles: validation data. Statistical indicators: concordance index (d), efficiency index (Ef), maximum error (ME), Root-mean-square error (RMSE) and Mean Absolute Error (MAE).

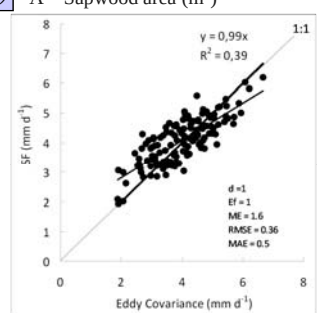

Figure 7. Comparison of daily transpiration derived from SF measurements with daily ETR measured by EC for days with negligible soil evaporation (dry superficial soil layer). Statistical indicators: concordance index (d), efficiency index (Ef), maximum error (ME), Root-mean-square error (RMSE) and Mean Absolute Error (MAE).