Using potential evapotranspiration to determine nighttime sap flow rate for Granier's method

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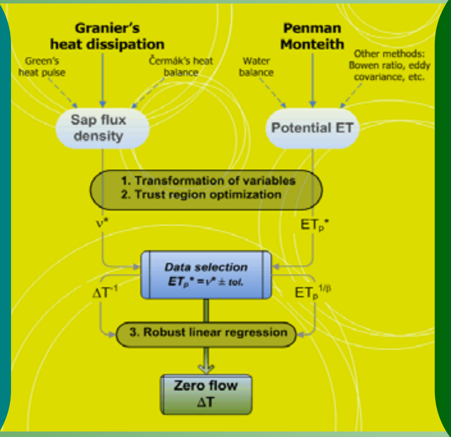
21-24 October 2008

Intro:

Nighttime sap flow may remain undetected when using heat-based systems requiring a zero flow calibration, such as the Granier's thermal dissipation technique. Since sap flux density is related to evapotranspiration, thermal dissipation probes (TDP) readings and micrometeorological data during daylight hours can be combined to predict the **true temperature difference between a heated and an unheated probe when sap flow is zero (ΔT_{max}).**



Methods:

The proposed method makes use of optimization techniques and a restatement of Granier's original formula, implemented into a MatLab® user-friendly computer program.

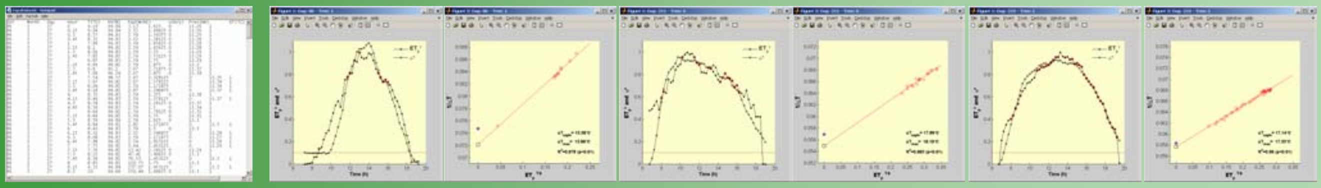
The software requires air temperature, relative humidity, solar radiation, wind speed, ΔT time series, the maximum ΔT peak at nighttime (ΔT_{night}), and the parameters for the Penman-Monteith approach.

The method was applied to Granier sap flow TDPs measurements obtained from forest tree species in a selected watershed within the evergreen subtropical forest in the Garajonay National Park (La Gomera), *Erica arborea* and *Myrica faya* laurisilva tree species.

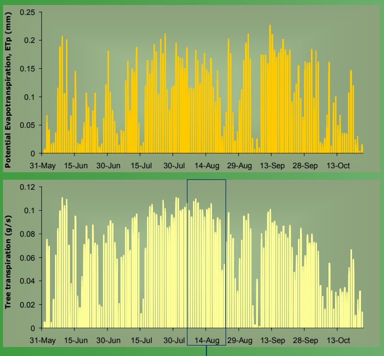
Concomitantly, microclimatic variables were monitored with micrometeorological sensors located above the canopy. Potential evapotranspiration (ET_p) estimations were obtained from micrometeorological readings using the Penman-Monteith approach, where the canopy surface resistance was considered to vary with the stomata response to environmental factors according to Jarvis (1976) and Stewart (1988).

Results:

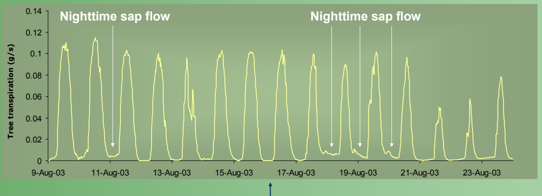
1. Software snapshots showing examples of ΔT_{max} determinations.



2. Potential evapotranspiration and tree transpiration for a selected period.



3. Nighttime sap flow examples.



Conclusions:

The proposed method was shown to be useful for computing ΔT_{max} using Granier's thermal dissipation technique, without the restriction of zero nighttime sap flux density. It has the potential of being applied not only to Granier's principle, but to others heat-based sap flow systems which require a zero flow calibration, such as the Čermák et al. (1973) heat balance method and the T-max heat pulse system of Green et al. (2003).

Further reading: C.M. Regalado & A. Ritter (2007). Tree Physiol. 27: 1093-1102.

Acknowledgements: This work has been funded by INIA projects RTA2001-097 and RTA2005-228.

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