COMMENTS ON THE PSYCHROMETRIC DETERMINATION OF LEAF WATER POTENTIALS IN SITU

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SUMMARY

Leaf diffusion resistances may lower the values of leaf water potentials found by in situ measurements with silver-foil psychrometers. With the instrumentation used, the bias ranges from zero to increasing negative deviations as leaf diffusion resistances become larger than 3.5 cm⁻¹ sec⁻¹.

Water potentials determined with the dewpoint technique are unaffected by diffusion resistances. In situ measurements by this method may also be carried out with the silver-foil sensor.

Hence, one and the same sensor may serve to trace both leaf water potentials and leaf diffusion resistance through dewpoint and psychrometric measurements.

INTRODUCTION

Correctly so, Nobel states that 'the structure of cells as well as that of ecosystems is governed by the initial supply of free energy and by the inexorable laws of thermodynamics which describe the expenditure of that free energy'.

Of all the processes resulting in the growth and development of plants, the flow of water in the continuum soil-plant-atmosphere is most demanding in energy. Supply- and demand rates of water are prime factors to which differences in vegetational structure and function can be attributed.

The chemical potential of water represents the free energy involved when moving one mole of water from some point in the system to a reference pool of pure water; all at atmospheric pressure and at the same temperature.

The quantity called water potential, $\Psi$, and conveniently defined...
as the ratio between the chemical potential of water, \( \mu_{w} \), and the partial molal volume of water, \( V_{w} \), has proved to be of value when attempting to quantitatively describe plant-water relations. Differences in \( \Psi \) may be considered to represent the driving force in transport equations; analogous to differences in electrical potential occurring in Ohm's law.

The relationship between the potential of water in the vapour phase and the relative humidity, \( U \), is given by the thermodynamically derived formula:

\[
\Psi = \frac{RT}{V_{w}} \ln U
\]  

(1)

If \( \Psi \) is expressed in bars, the international gas constant, \( R \), may be taken as 83.15 bar cm\(^3\) °K\(^{-1}\) mole\(^{-1}\); \( V_{w} \) equals 18 cm\(^3\) mole\(^{-1}\); and \( U \) equals \( e_{d}/e_{a} \), the dimensionless ratio between the saturation