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From theory to practice - and back again. How sap flow sensors could need correction techniques and statistical reminders to know their reliability and expiration date

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Whole plant transpiration is a crucial component in the hydrological cycle and a key parameter in many disciplines like agriculture, forestry and ecology. Sap flow measurements are one of the most widely used methods to estimate whole plant transpiration in woody plants because it is readily automated for continuous data readings. Several different methods have been developed and adjusted to different climatic conditions and wood properties. The variety of methods gives the option of commercially bought or self-manufactured sensors. Marshall (1958) first published the main theory the technique is built on: tracing the velocity of introduced heat within the xylem. Among the different heating techniques, the heat pulse and the heat ratio has been most widely used.

Regardless of the approach, early publications suggest that sap flow sensors should be installed for only 3 - 4 weeks at the time. Studies from the current decade indicate sensor placement for years at the time with little reference to quality check of a long-term continuous reading. The scientific literature identifies as the main sources of error; misalignment of the probes, wound corrections, thermal diffusivity, stem water content and placement of sensors in sapwood. Some of them are depend on time and, therefore, periodic and systematic controls must be carried out to monitor errors incurred during the determination of sap flow. This study looks at the time aspect of sap flow sensors in-situ and aims to close the gap between theory and practice with sap flow instalment and maintenance.

Continuous field measurements of sap flow were obtained from twelve grown individuals of Aleppo Pine (Pinus halepensis) during a period of two years under Mediterranean weather conditions for stand transpiration estimations. The method developed by Burgess et al. (2001) is generally followed with additional basic statistical processing incorporated in the pre- and post-data handling, so a thorough quantification was made for each particular sensor. Probe misalignment correction techniques were introduced in both vertical and horizontal axes, selecting the appropriate data periods among the pre-drawn saturated precipitation events when sap flow is negligible.

This study concludes that even when geometrical misalignments errors are small, the introduced corrections can imply an important data shift so as to be necessarily considered. Additionally, statistical records of the ratio of temperature differences were analysed and interpreted as a function of sensor degradation. In conclusion, no general time limit can be decided for all sensors, but should rather be determined from individual performance over time.

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