Implexx Sap Flow Sensor

versus

Trunk Heat Balance (THB)

Summary Table of Features:

Feature	Implexx Sap Flow Sensor	Trunk Heat Balance
Accuracy	±3%	Underestimates sap flow by 21.5% (Flo et al 2019)
Sap flow measurement range	Full range possible	Limited range, 0 to 0.25 kg/h
Measures stem water content?	YES	NO
Affected by ambient temperature?	NO	YES
Measures reverse flow or hydraulic redistribution?	YES	NO
Multiple measurement points?	YES	NO
SDI-12 digital output?	YES	NO
Supports low cost loggers?	YES	NO
Supports internet enabled devices such as LoRaWAN and NB-IoT?	YES	NO
Outputs multiple parameters?	YES	NO
Calibrated?	YES	NO
Requires low or small power supply?	YES	NO
Easy to manage in the field?	YES	NO
Theoretically derived method?	YES	NO

Details:

The Implexx Sap Flow Sensor is different to the trunk heat balance (THB) method with the following features:

- The Implexx sensor has a unique calibration equation which can be applied to many woody species for accurate estimations of sap flow. The THB sensors are typically not calibrated and they can potentially underestimate sap flow by 21.5% (Flo et al 2019).

- The Implexx sensor has SDI-12 digital output which means many sensors can potentially be connected to a small, low cost data logger. In contrast, most THB sensors have a dedicated data logger which the user is forced to accept the manufacturer's settings.

- The Implexx sensor can measure sap flux density, sap flow, transpiration and stem water content simultaneously. The THB only measures sap flow.

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- The Implexx sensor outputs multiple parameters that are extremely important for plant physiology and plant water use research. These parameters include total tree sap flow, outer and inner sapwood sap flow, stem temperature, stem water content, and sapwood thermal properties.

- The Implexx sensor has a short, 3 second heat pulse whereas the THB sensor needs constant and continuous heat, 24 hours a day, 7 days a week. The continuous power requirement of the THB sensor means it requires larger solar panels and batteries.

- The Implexx sensor has a maximum power consumption of 270mA for 3 seconds during a heat pulse and around 4mA at other times. The THB requires a continuous power consumption of ~400mA which means it needs large solar panels and batteries.

- The THB method assumes there is zero sap flow during the night or requires a period of zero flow in order to accurately calculate sap flow. Therefore, the THB sensor is not accurate until it is certain a zero flow condition has been accurately calculated. However, sap flow is nearly always above zero at night and is typically around 12% of total daily flow. Night-time sap flow is particularly high in desert, sub-tropical, tropical and savannah style biomes where night-time sap flow can be as high as 40%. Any night-time sap flow means the THB sensor cannot accurately estimate sap flow.

- The THB can only measure at one depth in the sapwood whereas the Implexx sensor can measure at multiple depths. This is extremely important as many students have demonstrated that sap flow varies across the radial profile of the tree. That is, sap flow is usually higher towards the outside of the tree and lower towards the inside of the tree. The Implexx Sap Flow Sensor can measure this variation for an accurate overall measurement of tree sap flow. The THB sensors cannot measure this and can lead to significant errors in tree sap flow measurements.