Application Note

LF101A - Leaf Wetness Data Logging System

Dielectric Leaf Wetness Sensor

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LWS Theory

How The LWS Works

The LWS measures the dielectric constant of a zone approximately 1 cm from the upper surface of the sensor. The dielectric constant of water (80) and ice (5) are much higher than that of air (1), so the measured dielectric constant is strongly dependent on the presence of moisture or frost on the sensor surfaces. The sensor outputs the a mV signal proportional to the dielectric of the measurement zone, and therefore proportional to the amount of water or ice on the sensor surface.

How the LWS Mimics a Real Leaf

The sensor has been specially designed to closely approximate the thermodynamic properties of a leaf. If the specific heat of a leaf is estimated at 3750 J kg-1 K-1, the density is estimated to be 0.95g/cm3, and the thickness of a typical leaf is 0.4 mm, then the heat capacity of the leaf is 1425 J m-2 K-1. This is closely approximated by the thing (0.65mm) fiberglass construction of the LWS, which has a heat capacity of 1480 J m-2 K-1. By mimicking the thermodynamic properties of a real leaf, the LWS is able to more closely match the wetness state of the canopy.

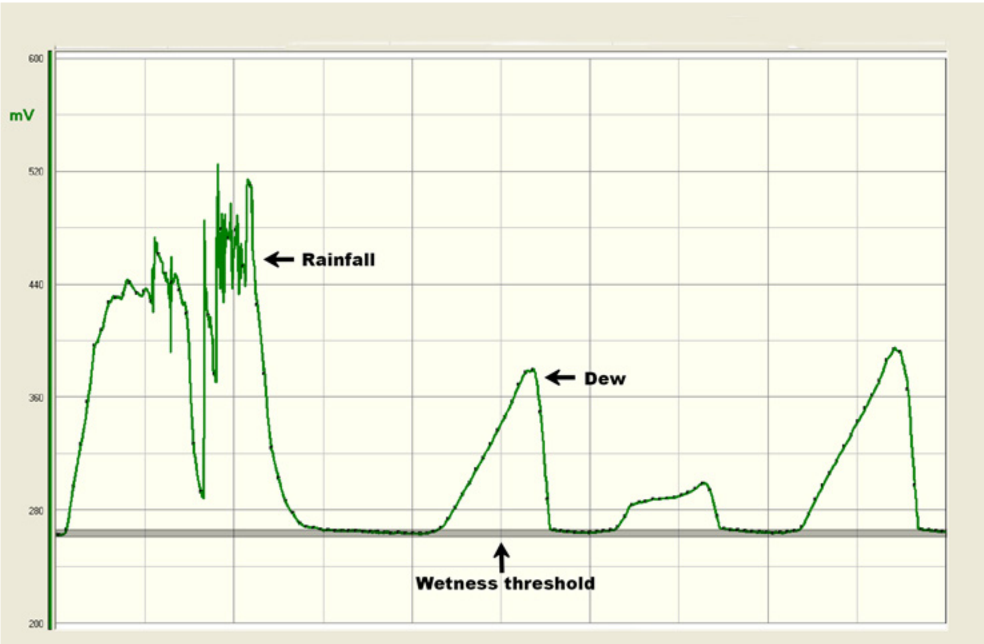
The sensor has also been engineered to closely match the radiative properties of real leaves. Healthy leaves generally absorb solar radiation effectively in much of the visible portion of the spectrum, but selectively reject much of the energy in the near-infrared portion of the spectrum. The surface coating of the LWS absorbs well in the near-infrared region, but the white color reflects most of the visible radiation. Spectroradiometer measurements indicated that the overall radiation balance of the sensor closely matches that of a healthy leaf. During normal use, prolonged exposure to sunlight can cause some yellowing of the LWS. This is expected and will not affect the probe’s function.

The surface coating of the LWS is hydrophobic – similar to a leaf with a hydrophobic cuticle. The sensor should match the wetness state of these types of leaves well, but may not match the wetness duration of leaves with plentiful leaf hairs or less waxy cuticles. It is impossible for any sensor to accurately mimic the properties of all leaves.

The LWS is engineered to be repeatable among units, so that relationships can be determined between the wetness state of the sensor, and the wetness state of various agricultural or natural plant canopies. Painting and individual sensor calibration is not necessary with the LWS.

Interpeting Data

Most leaf wetness applications (disease forecasting, etc.) don’t require knowledge of the amount of water on the surface – only if there is any water on the surface. To make this determination, a sensor output threshold corresponding to the minimum wet state must be identified.



When read with the LF101A data logger, the LWS outputs 266 mV when dry. When the sensor is totally wet, as in a heavy rain, the signal can range up to around 833 mV. Varying amounts of water on the surface of the sensor case a sensor output proportional to the amount of water on the sensor's surface.

Because ice has a much lower dielectric constant than that of liquid water, the sensor output from frost will be much lower than that from a similar amount of rain or dew.

Note that over time, the accumulation of dust and bird droppings can cause the dry output to rise. We recommend that the sensors be cleaned using a moist cloth periodically, or when elevated dry output is detected.

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