edaphic scientific
environmental research & monitoring equipment

evapotranspiration

measure ET_o or ET_c with the ATMOS 41 weather station

overview

- Measure Penman-Monteith FAO56 or ASCE evapotranspiration
- Optional crop factors, or K_c, available
- Measure via the compact, low cost, all-in-one, ATMOS 41 weather station
- Measure transpiration directly via the implexx sap flow sensor
- LoRaWAN, NB-IoT, Cat-M1, modem, and internet compatible
- Ideal for hydrology and irrigation applications

low cost and easy to use

Edaphic Scientific supplies a complete solution for the monitoring and measurement of evapotranspiration. We supply all the weather sensors and data loggers calibrated programmed and ready to measure. All the data can be accessed over the internet via the Eagle or Zentra online platforms. There is also a choice of over 34 different evapotranspiration equations. Whether your application is hydrology, irrigation management, scientific research, or more, Edaphic Scientific can provide an evapotranspiration monitoring solution.

ATMOS 41 all-in-one weather station

Evapotranspiration is calculated from solar radiation, temperature, humidity (or vapour pressure), and wind sensors.

The ATMOS 41 is a compact weather station with all these sensors included.

There is no need to purchase sensors from multiple suppliers, the ATMOS 41 provides all the sensors necessary to measure evapotranspiration.

The ATMOS 41 also measures additional weather parameters including rainfall (precipitation), relative humidity, vapour pressure deficit, and more.

internet access to data

Evapotranspiration measurements and data are accessed over the internet via the Eagle or Zentra online platforms.

The Zentra platform offers basic features including reference crop evapotranspiration calculated via Penman Monteith FAO56, data viewing, and downloading and exporting data to an Excel file.

The Eagle platform offers highly flexible and advanced features including evapotranspiration calculated by a choice of over 34 equations (including Penman Monteith FAO56 or ASCE methods), inclusion of crop factors (K_c), comparisons with actual transpiration measured via the Implexx Sap Flow Sensor, alarms, alerts and more.

If you do not have access to the internet, you can still download evapotranspiration data manually with a USB cable and laptop computer with the ES-SYS range of data logging systems.

IoT, LoRa, NB-IoT, Cat-M1 compatibility

The ATMOS 41 weather station for reference crop evapotranspiration measurements is compatible with a range of internet of things devices such as LoRa WAN, NB-IoT, Cat-M1 modems, and many more.

It is also possible to measure tree transpiration directly with the Implexx Sap Flow Sensor on these IoT devices.

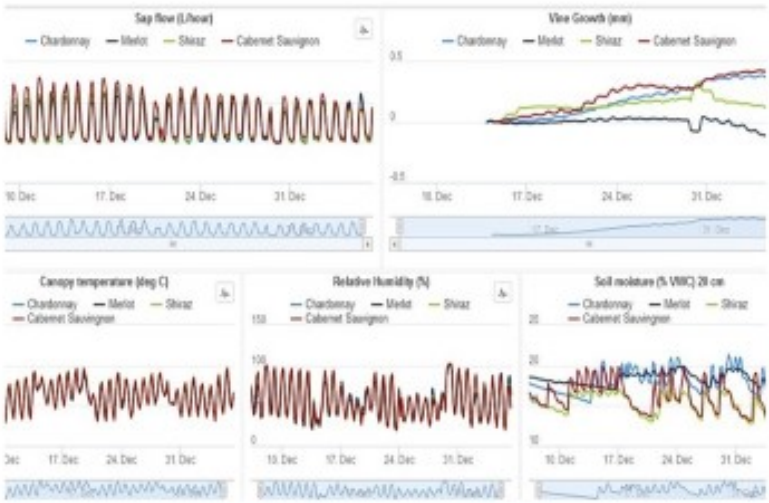
The scientists and engineers at Edaphic Scientific can assist you in setting up and providing evapotranspiration measurements on your IoT devices and networks. Contact us for more details.

which evapotranspiration method should be used?

Evapotranspiration can be calculated from numerous methods and equations. For example, Djaman et al's (2018) paper in *Theoretical and Applied Climatology* compared over 34 different evapotranspiration equations!

Edaphic Scientific has you covered. We provide industry standard equations, including Penman-Monteith FAO56 of the ASCE recommended method, or we can provide any other evapotranspiration. Our system is entirely flexible and you can use any equation you require. It is also possible to include your own, or novel, evapotranspiration equations in the Eagle platform.

measure reference crop or actual evapotranspiration



Edaphic Scientific has the capability to measure reference crop and/or actual evapotranspiration. It is important to understand the difference between reference crop and actual evapotranspiration because the results can have significant implications for hydrological or irrigation management.

Reference crop evapotranspiration, often referred to as ET_o, is the value that is

provided by official government weather stations such as the World Meteorological Organisation (WMO) or Bureau of Meteorology (BOM).

Reference crop evapotranspiration is calculated via the Penman-Monteith FAO56 or ASCE methods. Typically, irrigation managers, or those involved in agronomy or crop science, use Penman-Monteith FAO56 evapotranspiration; whereas hydrologists and engineers, or those involved in industries such as groundwater monitoring, phytocaps, mining and landfills, use the ASCE method.

The difference is subtle but important: the Penman-Monteith FAO56 method is based on a reference crop of a hypothetical grass that is 12 cm, or 0.12 m, or 4.72 inches, in height; whereas the ASCE method is based on a reference crop of an alfalfa plant that is 0.5 m, or 19.69 inches, in height. There are other differences and detailed information can be found in Xiang et al (2020) paper in *Agricultural Water Management*.

The Zentra platform only outputs evapotranspiration via the Penman-Monteith FAO56 method.

The Eagle platform can output evapotranspiration via the ASCE, Penman-Monteith FAO56, or any other method.

Reference crop evapotranspiration only provides information on evapotranspiration from a grass or alfalfa crop. For many irrigation managers or hydrologists, their crop or plant of interest will be something different. For example, an irrigation manager will be interested in horticultural crops such as grapevines, almonds, citrus, avocados, and so on. A hydrologist may be interested in trees such as eucalypts, oaks, pines, or other. For these plants, the actual evapotranspiration will vary from reference crop evapotranspiration and a crop factor (K_c) must be included, as discussed by Rana and Katerji (2000) in a review paper in the *European Journal of Agronomy*.

crop factors (K_c) and plant total leaf area

Edaphic Scientific, through the Eagle online platform, can provide a crop factor (K_c) for your specific crop.

The crop factor for evapotranspiration may be provided through a table of published values or the scientists at Edaphic Scientific can assist you in establishing your own, unique crop factor.

Once a crop factor is included, the Eagle platform can then output both reference

crop and actual evapotranspiration.

measure tree transpiration via the implexx sap flow sensor

It is possible to measure tree transpiration directly via the Implexx Sap Flow Sensor. This will provide actual transpiration numbers which can then be compared directly with reference crop or actual evapotranspiration.

Measuring tree transpiration directly is an ideal tool for irrigation management. Under optimal conditions, crop transpiration, measured via the Implexx Sap Flow Sensor, will equal actual evapotranspiration, measured via the ATMOS 41 weather station. When crop transpiration is less than actual evapotranspiration, then it is time to irrigate.

Hydrologists and engineers also need to know tree transpiration. These data are critical for water budgets and hydrological modelling. They can also be used for other applications such as groundwater monitoring for groundwater dependent ecosystems, or applications such as phytocaps, landfill or mine site water management.

evapotranspiration and broad-acre cropping

specifications

Solar radiation	Range: 0 to 1750 W/m^2 Resolution: 1 W/m^2 Accuracy: ± 5%
Precipitation	Range: 0 to 125 mm/hr Resolution: 0.017 mm Accuracy: ± 5% of measurement from 0 to 50 mm/hr
Air temperature	Range: -40 to 50° C Resolution: 0.1° C Accuracy: ± 0.6° C
Humidity sensor temperature	Range: -40 to 50° C Resolution: 0.1° C Accuracy: ± 1.0° C
Relative humidity	Range: 0 to 100% Resolution: 0.1% Accuracy: 3% typical, varies with temperature and humidity
Vapor pressure	Range: 0 to 47 kPa Resolution: 0.01 kPa Accuracy: ± 0.2 kPa typical below 40° C, varies with temperature and humidity
Barometric pressure	Range: 50 to 110 kPa Resolution: 0.0015 kPa Accuracy: ± 0.1 kPa
Wind speed	Range: 0 to 60 m/s Resolution: 0.01 m/s Accuracy: the greater of 0.3 m/s or 3% of measurement

Wind gust	Range: 0 to 60 m/s Resolution: 0.01 m/s Accuracy: the greater of 0.3 m/s or 3% of measurement
Wind direction	Range: 0 to 359° Resolution: 1° Accuracy: ± 5°
Compass heading	Range: 0 to 359° Resolution: 1° Accuracy: ± 5°
Sensor tilt	Range: 0 to 180° Resolution: 0.1° Accuracy: ± 1°
Lightning strike counter	Range: 0 to 65535 Resolution: 1 strike Accuracy: varies with distance, > 25% detection at <10 km typical
Lightning distance	Range: 0 to 40 km Resolution: 3 km Accuracy: unspecified

manual & docs

- ATMOS 41 Manual
- ATMOS 41 Brochure
- ATMOS 41 Integrators Guide

related products

- Eagle online platform
- Zentra online platform

- ZL6 Data Logger for the ATMOS 41
- LoRaWAN, modems and wireless monitoring systems
- Weather sensors and stations
- Soil moisture sensors, probes and meters
- Implexx sap flow sensor