

Appendix

The procedures and equations used to compute the variables presented in Equation 2 are described in this Appendix. The variables are presented in the order they are encountered in Eq. 2.

Δ: Slope of Saturation Vapor Pressure vs. Temperature Relationship

The slope of the saturation vapor pressure versus temperature relationship, Δ (kPa °C⁻¹), is computed using:

$$\Delta = 2503 \exp((17.27T)/(T + 237.3))/(T + 237.3)^2 \quad (A1)$$

where T is the mean temperature for the day (°C).

Rn: Net Radiation

Net radiation is the net amount of radiant energy available at the surface for evaporating water. Rn includes both short and long wave radiation and is computed using:

$$Rn = Rns - Rnl \quad (A2)$$

where Rns = net shortwave radiation (MJ m⁻² d⁻¹) defined as positive in the downward direction (toward earth) and Rnl = net longwave radiation (MJ m⁻² d⁻¹) defined as positive in the upward direction (toward sky).

Net shortwave radiation (Rns) is computed as the difference between incoming and reflected shortwave radiation:

$$Rns = Rs - \alpha Rs = (1 - \alpha)Rs \quad (A3)$$

where α = albedo or canopy reflection coefficient which is fixed at 0.23 and Rs = incoming solar radiation (MJ m⁻² d⁻¹).

Net longwave radiation (Rnl) is the difference between upward longwave radiation (Rlu) and downward longwave radiation from the sky (Rld):

$$Rnl = Rlu - Rld \quad (A4)$$

The daily value of Rnl is computed using:

$$Rnl = \sigma[(Tk^4_{max} + Tk^4_{min})/2] * (0.34 - 0.14 \sqrt{ea}) [1.35(Rs/Rso) - 0.35] \quad (A5)$$

where Rnl is net long-wave radiation in MJ m⁻² d⁻¹, σ is the Stefan-Boltzman constant [= 4.901 × 10⁻⁹ MJ K⁻⁴ m⁻² d⁻¹], Tk⁴_{max} is the maximum absolute temperature for the day (K), Tk⁴_{min} is the minimum absolute temperatures for the day (K), ea is the actual vapor pressure (kPa), Rs is solar radiation (MJ m⁻² d⁻¹), and Rso is calculated clear-sky solar radiation (MJ m⁻² d⁻¹). The ratio Rs/Rso indicates the relative level of cloudiness must be limited to 0.3 < Rs/Rso < 1.0. Rs/Rso values < 0.30 are set = 0.30; Rs/Rso values > 1.0 are set = 1.0.

Clear sky solar radiation (R_{so}) is computed using:

$$R_{so} = (0.75 + 2 \cdot 10^{-5} z) R_a \quad (A6)$$

where z is the elevation above sea level (m) and R_a is extraterrestrial radiation ($\text{MJ m}^{-2} \text{d}^{-1}$).

Extraterrestrial radiation is computed from earth-sun geometry using:

$$R_a = (24/\pi) G_{sc} dr [\omega_s \sin(\varphi) \sin(\delta) + \cos(\varphi) \cos(\delta) \sin(\omega_s)] \quad (A7)$$

where G_{sc} is the solar constant [$= 4.92 \text{ MJ m}^{-2} \text{h}^{-1}$], dr is relative distance factor (between the earth and sun), ω_s is sunset hour angle (radians), φ is the latitude (radians), and δ solar declination (radians).

The relative distance factor is computed using:

$$dr = 1 + 0.033 \cos(2\pi J / 365) \quad (A8)$$

where J is the day of the year ($1 = 1$ January; $365 = 31$ December).

The solar declination angle is computed using:

$$\delta = 0.409 \sin((2\pi J / 365) - 1.39) \quad (A9)$$

The sunset angle is computed using:

$$\omega_s = \arccos[-\tan(\varphi) \tan(\delta)] \quad (A10)$$

γ : Psychrometer Constant

The psychrometer constant, γ ($\text{kPa } ^\circ\text{C}^{-1}$), is computed using:

$$\gamma = 0.000665 P \quad (A11)$$

where P is the atmospheric pressure at the weather station site. Atmospheric pressure (kPa) is computed from the elevation of the weather station site:

$$P = 101.3 ((293 - 0.0065 z) / 293)^{5.26} \quad (A12)$$

where z is the elevation of the weather station above mean sea level (m).

T: Mean Air Temperature

Mean air temperature ($^\circ\text{C}$) is calculated as the mean of the daily maximum and daily minimum air temperature:

$$T = (T_{\max} + T_{\min}) / 2 \quad (A13)$$

where Tmax and Tmin are the maximum and minimum air temperatures (°C) as obtained from the weather station data logger.

U₂: Wind Speed

The standardized equation requires the mean daily wind speed measured at 2 m above ground level (agl). Because AZMET measures wind speed at 3 m agl, wind speed is adjusted to an equivalent value at 2 m agl using the following:

$$U_2 = U_3 (4.87 / \ln(67.8 z_w - 5.42)) \quad (A14)$$

where U_3 is the wind speed measured at 3 m agl and z_w is the height of the wind speed measurement (3 m).

e_s: Saturation Vapor Pressure

Saturation vapor pressure is computed using:

$$e_s = (e_s(T_{max}) + e_s(T_{min})) / 2 \quad (A15)$$

where $e_s(T_{max})$ and $e_s(T_{min})$ are the saturation vapor pressures (kPa) computed using the maximum and minimum air temperatures, respectively. Saturation vapor pressure is computed using the following:

$$e_s = 0.6108 \exp((17.27 T_{ex}) / (T_{ex} + 237.3)) \quad (A16)$$

where T_{ex} is either Tmax or Tmin (°C) .

e_a: Actual Vapor Pressure

The mean actual vapor pressure for the day is computed by the weather station datalogger using simultaneous measurements of relative humidity (RH; %) and air temperature (T_a ; °C) using:

$$e_a = (RH / 100) [0.6108 \exp((17.27 T_a) / (T_a + 237.3))] \quad (A17)$$

Values of e_a are computed by the datalogger every 10 s and averaged for the day.

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