CIMIS Equation

The CIMIS Equation is a version of the Modified Penman Equation (Pruitt and Doorenbos, 1977) with a wind function developed at the University of California, Davis. The input variables used in the CIMIS equation and the steps required to calculate ETo are described below.

Variables Required

ea = Mean hourly vapor pressure (kPa)
RH = Mean hourly relative humidity (%)
Rn = Mean hourly net radiation (Wm^{-2})
T = Mean hourly air temperature (Celsius)
U = Mean hourly wind speed at 2 meters (ms^{-1})
Z = Elevation of the station above mean sea level (m)
A = surface reflectance (albedo)
Rs = measured solar radiation ($W\ m^{-2}$)
T_o = clear sky effective temperature (K)
T_c = cloud base temperature (K)
ε_s = surface emissivity (≈ 1)
ε_o = clear sky emissivity
c = fraction of cloud cover
σ = Stefan-Boltzmann constant ($5.67 \times 10^{-8}\ W\ m^{-2}\ K^{-4}$)
k = empirical coefficient for local cloud properties
T_s = the surface temperature (K).

Steps

1. **Convert temperature from Celsius to Kelvin**

   $T_k = T + 273.16$

2. **Calculate saturation vapor pressure**

   $es = 0.6108 * \exp(T * 17.27/ (T + 237.3))$

3. **Calculate vapor pressure deficit (VPD)**

   VPD = es - ea (kPa)

4. **Calculate the slope of the saturation vapor pressure vs. air temperature curve at the average hourly air temperature (DEL)**

   $DEL = (4099 * es)/(T + 237.3)^2$

5. **Calculate barometric pressure**

   $P = 101.3 - 0.0115 * Z + 5.44 * 10^{-7} * Z^2$

6. **Calculate psychrometric constant (GAM) ($kPa\ C^{-1}$)**

   GAM = 0.000646 (1 + 0.000946*T) P

7. **Calculate weighting function (W)**

   W = DEL/(DEL + GAM)

8. **Calculate wind function (FU2)**

   For Rn<=0 (nighttime)
   FU2 = 0.125 + 0.0439U

   For Rn>0 (daytime)
   FU2 = 0.030 + 0.0576U

9. **Calculate net radiation (Rn) (Dong et al., 1992)**

$$Rn = (1-\alpha)Rs + \varepsilon_s\left[\varepsilon_o(1-c)\sigma T_o^4 + c(\sigma T_c^4 - k)\right] - \varepsilon_s \sigma T_s^4$$

10. **Convert Rn from Wm^{-2} to mm (NR)**

    NR = Rn/(694.5 (1-0.000946*T))

11. **Calculate Hourly Reference Evapotranspiration (RET)**

    RET = W*NR + (1-W)VPD * FU2

12. **Daily ETo equals the sum of 24 hours RET (mm)**

References

Pruitt, W. O., and Doorenbos, J. (1977). “Empirical calibration, a requisite for evapotranspiration formulae based on daily or longer mean climatic data?.” ICID Conference on Evapotranspiration, Budapest, Hungary, 20 pp.

Dong, A., Grattan, S. R., Caroll, J. J., and Prashar, C. R. K. (1992). “Estimation of daytime net radiation over well-watered grass.” *J. Irrig. and Drain. Engr*., ASCE, 118(3), 466-479.