Assignment 1: Coding Models for Potential Evapotranspiration

The transfer of water from the surface to the atmosphere through evaporation and transpiration (E + T = ET) is a critical process in the Earth System. An accurate picture of ET rates is needed for a range of applications. For one, ET is a major component of soil water balance, so that ET rates influence soil moisture and efforts to predict things like plant production therefore require ET estimates. For another, ET rates influence sensible heating which drives convection.

We have talked in class about different approaches to modeling potential ET (PET). In this exercise you will code functions for six common methods, and later in the quarter you will use these functions to evaluate model differences. Hand in code with functions, and also numeric answers for question 2.

Exercises

1. (4 pts)

Write six functions to compute PET using the six different methods outlined below, where the input depends on the model and the output is PET.

Method 1, Priestly Taylor:

$$PET = a\frac{s(R_n - G)}{\lambda(s + \gamma)}$$

$a = 1.26$
$s =$ slope of vapor pressure curve
$\gamma =$ psychrometric constant
$G =$ ground heat flux (assume $= 0$)
$R_n =$ net radiation
$\lambda = 2.501 - 0.002361(T_{mean})$

Note: A function to compute R_n from temperatures and radiation is provided in exercise1.functions.r.

Method 2, Modified Priestly Taylor:

$$PET = \begin{cases} EEQ * 0.01 * exp(0.18 * (T_{max} + 20)), & T_{max} < 5 \\ EEQ * 1.1, & 5 <= T_{max} <= 24 \\ EEQ * ((T_{max} - 24) * 0.05 + 1.1), & T_{max} > 24 \end{cases}$$

where:
$EEQ = R_s(4.88x10^{-3} - 4.37x10^{-3} * albedo) * (TD + 29)$
$TD = 0.6 * T_{max} + 0.4 * T_{min}$
$albedo = 0.23$
$T_{max} =$ daily maximum temperature (C)
$T_{min} =$ daily minimum temperature (C)

Method 3, Hamon:

$$PET = 715.5 * DL * \frac{esat}{T_{mean} + 273.2}$$

where:
DL = daylength (days) (from latitude and day of year)
$esat$ = saturated vapor pressure, evaluated at T_{mean}

Method 4, Hargreaves:

$$PET = \frac{0.0023 * (T_{mean} + 17.8)(T_{max} - T_{min})^{0.5} R_a}{\lambda}$$

where $\lambda = 2.501 - 0.002361 * T_{mean}$

Method 5, Linacre:

$$PET = \frac{500 * \frac{T_m}{(100 - A)} + 15(T_{mean} - T_{dew})}{80 - T_{mean}}$$

where:
$T_m = T_{mean} + 0.006h$
h = elevation (m)
T_{dew} = dewpoint temp
A = latitude (degrees)

Method 6, Turc:

$$PET = \begin{cases} (1 + (50 - RH)/70)\frac{0.013 * T * (R_s + 50)}{T + 15}, & RH < 50\% \\ \frac{0.013 * T * (R_s + 50)}{T + 15}, & RH \geq 50\% \end{cases}$$

T = mean daily temp (C)
R_s = daily solar radiation (units of cal /cm2 which is 23.9 x value in MJ / m^2)
RH = daily mean relative humidity (%)

****NOTE:** Functions to compute R_n, R_a, day length, psychrometric constant, $esat$, and slope of vapor pressure curve are provided in exercise1.functions.r.

2. (1 pts)

Report PET according to each method for Aug 21, 2013 in Gilroy, CA, which had $Tmax = 27.7C$, $Tmin = 13.3C$, $RH = 67\%$, $Tdew = 13.9C$, and $R_s = 22.5MJ/m^2$.