

UC Davis Biometeorology Group

User's Guide for HRPM.EXE

Hourly Reference Evapotranspiration (ET_o) Calculator

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ET007 Quick Answer

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INTRODUCTION

The HRPM.EXE is an executable program that calculates reference evapotranspiration (ET_o) for a grass reference using hourly weather data and the Penman-Monteith equation. To obtain a copy, click on [HRPM](#). It is an executable program requiring no additional software. Inputs include the hourly (1) solar radiation ($W\ m^{-2}\ d^{-1}$), air temperature ($^{\circ}C$), wind speed ($m\ s^{-1}$), and humidity [dew point temperature ($^{\circ}C$)]. The program calculates ET_o using the Penman-Monteith equation (Monteith, 1965) following the guidelines recommended by the ASCE (Walter et al., 2000; Allen et al., 2000).

DATA ENTRY

Data are read from a comma delimited file with the extension “.csv”. To obtain a sample data set, click on [DavisHR.csv](#). A sample of the first few rows of DavisHR.csv is shown below. Any csv file with the same format can be analyzed. Note that the last three values in the first row are the current year, the previous year, and the Microsoft number identifying 31 December of the previous year. In this case, 37986 corresponds to 31 December 2003. When editing the data file in Excel, enter the equation ‘=date(2003,12,31)’, where the first four digits are the year number for the previous year, and Excel will automatically determine the date number.

Davis, 38.5, 122.5, 18.5, 120, 2004, 2003, 37986

Station, date, Time, DOY, Rs (W), T (°C), U2 (m/s), Td (°C)

6, 1-Jan-04, 1, 1, 0, 4.4, 1.3, 3.8

6, 1-Jan-04, 2, 1, 0, 4.2, 1.5, 3.7

6, 1-Jan-04, 3, 1, 0, 4.4, 2.3, 3.9

6, 1-Jan-04, 4, 1, 0, 5.8, 2.6, 5.4

6, 1-Jan-04, 5, 1, 0, 5.7, 1.5, 5.3

6, 1-Jan-04, 6, 1, 0, 4.5, 1.3, 4.2

6, 1-Jan-04, 7, 1, 0, 4.2, 1.4, 3.9

6, 1-Jan-04, 8, 1, 26, 4.4, 1.3, 4.1

6, 1-Jan-04, 9, 1, 77, 5.5, 1.1, 5.2

6, 1-Jan-04, 10, 1, 224, 7.1, 1.7, 6.2

It is not important to have the correct spacing between variables, but it is important to have commas between the variable names. The first row contains the site information (Name, latitude, longitude, elevation and longitude of the local time meridian). Note that the local time meridian for California “Pacific Time” is 120 degrees west of Greenwich, England. For longitudes east of Greenwich, use a negative number for the longitude and the time meridian. The second row contains the column headings. Each row contains the hourly mean data for solar radiation (R_s in $W\ m^{-2}$), temperature (T in $^{\circ}C$), wind speed (U_2 in $m\ s^{-1}$), and dew point (T_d in $^{\circ}C$).

OUTPUT

Reference evapotranspiration is calculated and the data are output to a file with the same name, but with the extension “.hly” in the following format.

davishr, 38.5, 122.5, 18.5, 120

Sta, CalDate, Hr, DOY, Rs, T, U, Td, Rn, G, H, LE, ETo

6, 1-Jan-04, 1, 1, 0, 4.4, 1.3, 3.8, -72.2, -36.1, -27.2, -8.9, -0.01

6, 1-Jan-04, 2, 1, 0, 4.2, 1.5, 3.7, -72.1, -36.1, -27.7, -8.3, -0.01

6, 1-Jan-04, 3, 1, 0, 4.4, 2.3, 3.9, -72.0, -36.0, -29.7, -6.3, -0.01

6, 1-Jan-04, 4, 1, 0, 5.8, 2.6, 5.4, -71.2, -35.6, -29.2, -6.3, -0.01

6, 1-Jan-04, 5, 1, 0, 5.7, 1.5, 5.3, -71.2, -35.6, -26.6, -9.0, -0.01

6, 1-Jan-04, 6, 1, 0, 4.5, 1.3, 4.2, -71.7, -35.8, -26.3, -9.5, -0.01

6, 1-Jan-04, 7, 1, 0, 4.2, 1.4, 3.9, -71.8, -35.9, -26.8, -9.1, -0.01

6, 1-Jan-04, 8, 1, 26, 4.4, 1.3, 4.1, -51.7, -25.9, -19.2, -6.6, -0.01

6, 1-Jan-04, 9, 1, 77, 5.5, 1.1, 5.2, -11.9, -5.9, -4.7, -1.2, -0.00

6, 1-Jan-04, 10, 1, 224, 7.1, 1.7, 6.2, 129.7, 13.0, 63.2, 53.5, 0.08

The first row again contains site information and the second row contains the column headings. In addition to the input variables, the variables net radiation (Rn in W/m²), soil heat flux density (G in W/m²), sensible heat flux density (H in W/m²), latent heat flux density (LE in W/m²), and reference evapotranspiration (ETo in mm/h) are saved. The flux density data and ETo are calculated using the approach of the ASCE hourly ETo method using the Penman Monteith equation.

The program also adds up the hourly data and outputs the daily sums to a file with the same name and an extension “.dly” in the following format.

davishr, 38.5, 122.5, 18.5, 120

CalDate, DOY, Rs, Tx, Tn, U2, Td, Rn, G, H, LE, ETo

1-Jan-04 , 1, 7.3, 11.5, 4.2, 1.8, 6.0, 1.5, -0.9, 1.8, 1.8, 0.9

2-Jan-04 , 2, 4.2, 11.1, 4.9, 1.7, 6.3, 1.1, -0.4, 1.7, 1.2, 0.5

3-Jan-04 , 3, 8.9, 14.2, 4.6, 2.2, 6.1, 2.9, -0.6, 2.2, 3.0, 1.3

4-Jan-04 , 4, 5.7, 14.6, 6.3, 1.4, 8.0, 0.7, -1.0, 1.4, 1.4, 0.7

5-Jan-04 , 5, 9.7, 18.1, 6.9, 5.1, 6.8, 2.7, -0.8, 5.1, 5.7, 2.3

6-Jan-04 , 6, 9.5, 14.0, 3.8, 2.3, 6.1, 2.2, -1.1, 2.3, 3.1, 1.3

7-Jan-04 , 7, 8.4, 15.3, 2.6, 2.5, 6.0, 1.7, -1.1, 2.5, 2.3, 1.0

8-Jan-04 , 8, 3.2, 8.6, 5.6, 1.8, 6.0, -0.7, -1.0, 1.8, 0.5, 0.3

9-Jan-04 , 9, 1.9, 8.2, 5.2, 1.5, 6.5, -0.6, -0.6, 1.5, 0.2, 0.1

10-Jan-04 , 10, 2.5, 13.1, 8.0, 3.1, 10.1, -0.1, -0.6, 3.1, 0.6, 0.3

The first two rows contain site information and column headings. The Rs data are in MJ m⁻², Tx and Tn are in °C, U₂ in m s⁻¹ average for the day, T_d is in °C, R_n, G, H, and LE are in MJ m⁻² and ETo is in mm d⁻¹.

CONVERSIONS

From Miles per hour (mph) to m s⁻¹ multiply by 0.447

From Miles per day (mpd) to m s⁻¹ multiply by 0.018625

From degrees Fahrenheit to degrees Celsius

$$^{\circ}\text{C} = \frac{5(^{\circ}\text{F} - 32)}{9}$$

REFERENCES

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Monteith, J.L. 1965. Evaporation and the environment. 205-234. In the movement of water in living organisms, XIXth Symposium. Soc. of Exp. Biol., Swansea, Cambridge University Press.

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