**Water balance model inputs and outputs: Daymet\_Penman\_Hamon\_Batch\_v2\_2.xlsm**

**The water balance model can be run with 4 different potential evapotranspiration equations, Penman, Hamon and two forms of the Oudin equation. The PET equations require different input variables. Penman is based on physical principles and is the most complex and requires the largest number of inputs in addition to temperature and precipitation. The other equations require daylength or solar radiation in addition to temperature and precipitation.**

**Inputs:**

Required:

Max and Min Temperature (deg C)

Precipitation (mm)

Latitude (decimal degrees)

Optional:

Water Holding Capacity (mm)

Slope (degrees optional)

Aspect (degrees optional)

Site name

Solar radiation (W/m^2)

Vapor pressure (Pa)

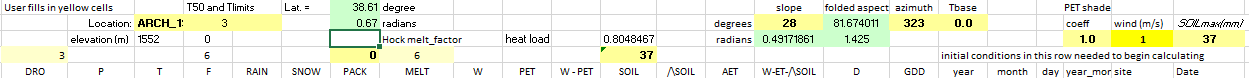
Wind speed (m/s)

Shade coefficient (0 to 1) multiplier that reduces PET

Input climate data are located in the sheet “paste\_Daymet\_data\_here” in columns A:I.

Latitude and elevation used in calculations must be in their own cells B1, and B4, respectively.

Other model input parameters are highlighted in yellow beginning at column BB.



DRO = Direct runoff (BB7)

Location = site name (BD5)

T50 = Jennings coefficient, or temperature for rain / snow transition (BE5)

Pack initial condition = mm of snow pack snow water equivalent (BH7)

Hock melt factor = mm of daily snowmelt when warm enough to melt (BI7)

Soil initial conditions = mm soil water stored in soil profile (BM7)

Slope = site slope in degrees (BP5)

Azimuth = slope aspect in degrees (BR5)

Tbase = Base temperature for calculating growing degree days (BS6)

Shade = fractional reduction in PET due to shade (0-1) (BV6)

Wind = wind speed (m/s) (BW6)

Soilmax = mm water holding capacity of soil (BX6)

Output units are mm for all water related terms and degrees Celsius for any temperature related term. Separate output files are created for daily, monthly and annual periodicity

**Annual Outputs**:

Row Labels– year of annual summary

Sum of P- annual sum of precipitation

Average of T– annual average temperature

Sum of RAIN– annual sum of precipitation as rain

Sum of SNOW– annual sum of precipitation as snow water equivalent

Max of PACK–maximum annual snow pack as snow water equivalent

Sum of MELT– annual sum of snow melt as water

Sum of W– sum of melt plus rain reaching soil surface

Sum of PET– annual sum of potential evapotranspiration

Sum of W - PET– annual sum of melt plus rain reaching soil surface minus potential evapotranspiration

Average of SOIL– annual average soil moisture

Sum of AET- annual sum of actual evapotranspiration

Sum of W-ET-/\SOIL– annual sum of excess water after available water holding capacity of soil saturated, also called runoff

Sum of D-annual sum of deficit which is PET-AET

Sum of GDD– annual sum of growing degree days

site– site name

**Monthly Outputs:**

Same as annual

**Daily Outputs:**

date - date

year - year

month- month of year

day – day of year

svp -saturation vapor pressure (Pa)

rh – relative humidity (%)

vpd – vapor pressure deficit (Pa)

DRO – direct runoff, or fraction of precipitation shunted to runoff (mm)

P – daily precipitation (mm)

T – daily average temperature (deg C)

F – temperature dependent constant used to partition precipitation into rain or snow

RAIN – daily precipitation as rain (mm)

SNOW – daily precipitation as snow (mm)

PACK – daily snowpack snow water equivalent (mm) accounting for daily additions and melt

MELT – daily snow melt (mm)

W – daily water reaching soil surface as snow plus rain (mm)

PET – potential evapotranspiration (mm)

W – PET – water reaching soil surface minus potential evapotranspiration (mm)

SOIL – soil moisture (mm)

/\SOIL – change in soil moisture from previous day (mm)

AET – actual evapotranspiration (mm), which is PET limited by soil water availability

W-ET-/\SOIL – runoff, or excess input greater than soil water holding capacity (mm)

D – climatic water deficit, which is PET – AET (mm)

GDD – growing degree days (deg C)

Site – site name

Dew – did dew form overnight (y/n)

Dingman, S. L. 2002. Physical Hydrology. 2nd ed. Prentice Hall, New Jersey

Lutz, J. a., Van Wagtendonk, J. W., & Franklin, J. F. (2010). Climatic water deficit, tree species ranges, and climate change in Yosemite National Park. Journal of Biogeography, 37(5), 936–950. doi:10.1111/j.1365-2699.2009.02268.x

Markstrom, G. J. M. and S. L. (2007). *A Monthly Water-Balance Model Driven By a Graphical User Interface* (p. 12). USGS Reston, VA.

