## Initialization

### Job Description

I am in the process of developing a hydrological model, and as of now I need guidance/help to use MATLAB to calculate the PET for the sub-basins that I've delineated. To my understanding, I will need to obtain solar radiation (using middle latitude) for each sub-basin and also max & min temperature + average temperature to be able to do the calculation. The process will make use of the climate model tool-box in MATLAB so experience in hydrological modeling and MATLAB is required.

### General Approach

1. Prepare data. You have to acquire solar radiation data and maximum, minimum temperature data for each sub-basin. You can obtain solar radiation data from meteorological stations, satellite data or climate databases. You can also obtain temperature data from those sources.

2. Preprocessing, meaning that ensures data format.

3. Use the Climate Data toolbox. This toolbox provides various methods and equations for PET calculation, such as the Penman-Monteith equation.

### Reference

<https://ww2.mathworks.cn/matlabcentral/fileexchange/70338-climate-data-toolbox-for-matlab>

### What is PET?

PET stands for Potential Evapotranspiration. It is a measure of the amount of water that could potentially evaporate and transpire from a given area if water was not limited. In hydrological modeling, PET is an important parameter used to estimate the water balance and understand the water availability in a specific region or sub-basin.

To calculate PET using MATLAB for your sub-basins, you will need the following data:

Solar radiation: You can obtain solar radiation data for each sub-basin using the middle latitude method. This method estimates solar radiation based on the latitude of the location.

Maximum and minimum temperature: You will need the maximum and minimum temperature data for each sub-basin. These temperatures are used in the calculation of PET.

Average temperature: The average temperature is also required to calculate PET. It can be calculated by taking the average of the maximum and minimum temperature for each sub-basin.

Once you have obtained these data, you can use the climate model toolbox in MATLAB to calculate PET for each sub-basin. The specific steps and functions to use will depend on the methodology or formulation you choose for PET estimation. You can refer to the MATLAB Central File Exchange for existing functions that estimate PET using different formulations

### How to calculate PET?

The PET Hargreaves equation is a widely used method to estimate potential evapotranspiration (PET), which is the amount of water that could be evaporated from the land surface and transpired by plants under ideal conditions.

The PET Hargreaves equation is as follows:

PET = 0.0023 \* (Tmean + 17.8) \* (Tmax - Tmin)^0.5 \* Ra

Where: PET = Potential evapotranspiration (mm/day) Tmean = Mean daily temperature (°C) Tmax = Maximum daily temperature (°C) Tmin = Minimum daily temperature (°C) Ra = Extraterrestrial radiation (mm/day)

To calculate Ra, you can use the following equation:

Ra = (24 \* 60 / π) \* Gsc \* Dr \* (ωs \* sin(φ) \* sin(δ) + cos(φ) \* cos(δ) \* sin(ωs))

Where: Ra = Extraterrestrial radiation (mm/day) Gsc = Solar constant (0.0820 MJ/m2/min) Dr = Inverse relative distance Earth-Sun (1 + 0.033 \* cos(2 \* π \* J / 365)) J = Day of the year (1-365) ωs = Sunset hour angle (radians) φ = Latitude (radians) δ = Solar declination (radians)

## Work Step

### 1. Install Climate Data Toolbox on Matlab

Climate Data Toolbox is open-source on Github: <https://github.com/chadagreene/CDT>

You can follow the installation step in Readme file.

### 2. Prepare data

Prepare data of Latitude, Longitude, Temperature according to date

You can download temperature data with specific latitude and longitude at <https://climexp.knmi.nl/selectdailyfield2.cgi?id=someone@somewhere>

Download raw data and run preprocess.py file for preprocessing.

### 3. Calculate solar radiation

Solar radiation can be uniquely determined with date and latitude. Solar radiation is affected by the position of the sun in the sky, which is determined by the date and latitude of the location. The solar radiation received at a particular location is also affected by the time of day, atmospheric conditions, and other factors.

Matlab function: Ra = solar\_radiation(t,lat);

Description:

solar\_radiation computes modern daily total extraterrestrial solar radiation received at the top of Earth's atmosphere.

Ra = solar\_radiation(t,lat) calculates the extraterrestrial radiation (MJ m^(-2) day^(-1)) based on the dates t and latitude lat. Dates t can be in datetime, datenum, or datestr format, but must be a 1D array or a scalar. lat can be scalar, vector, or grid. If lat is a vector or array with size nrows and ncols then Ra has the size [nrows,ncols,length(t)].

### 4. Calculate PET

PET is calculated based on the formula of Hargreaves and Samani (1985) which estimates reference crop evapotranspiration based on temperature and extraterrestrial radiation.

Matlab function: pevap = pet(Ra,TMAX,TMIN,T);

Description:

Matlab function uses the formula of Hargreaves-Samani (1985) which is a temperature based method to calculate the potential evapotranspiration (PET) and is implemented in the function pet. The main advantage of using the Hargreaves-Samani equation lies in its simplicity and low requirements regarding input parameters.

### 4. Code

Main code is project.m

It gets temperature source file, max-temperature source file, min-temperature source file, max-Latitude, min-Latitude, max-Longitude, min-Longitude of each mask.

And with those variables, it calls getResult() function.

getResult() function is defined in getResult.m

It returns Ra and PET of the specific mask. To retrieve temperature, max-temperature, min-temperature from source files, it uses getTemperature() function

getTemperature() function is defined in getTemperature.m