CIVE 625 – Quantitative Ecohydrology
Lab 2 – PART 1 (Due Date: March 18th)

The objective of this lab is for you to implement a simple hydrologic model that will be later used in the class to investigate some of the topics that will be discussed in Part 2 of the course. Hydrologic models vary in complexity, and the one you will be implementing in this Lab although being simple, can be assumed to represent the behavior of many watersheds.

As seen in class, the basic structure of this model uses a simple linear transformation between Potential Evaporation (PET) (aka: the atmospheric demand) and actual Evapotranspiration (ET). You will be asked to update the model's structure so that a more detailed formulation of ET can be used. This updated version of ET is very similar to the one implemented in the SVAT Lab (Lab1).

As this class requires a certain degree of familiarity with the structure of time-continuous conceptual hydrologic models and the understanding of how such models are implemented, I will be sharing some codes with you to speed up your progress. The codes will be shared in MATLAB, and you should be able to use the programming language of your choice by adapting it accordingly. I highly recommend using ChatGPT to help with code translation, it will make the job much easier.

Instructions:

Please note a few of the files uploaded on Canvas to be used as inputs:

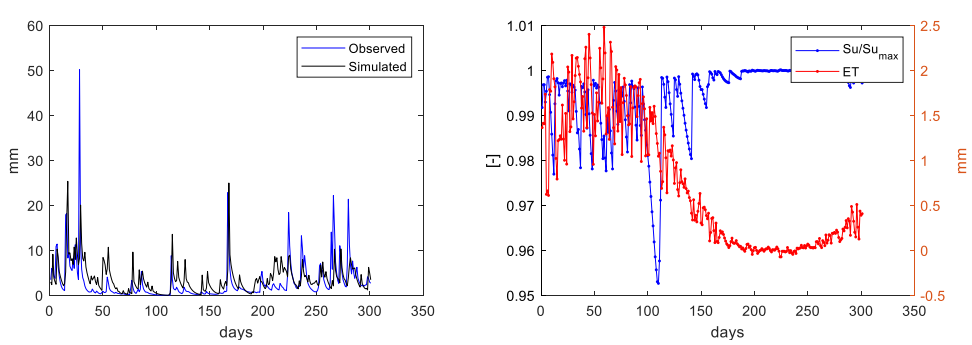
- **Q_mm.csv**: Streamflow data (Q) in millimeters (mm).
- **Precip.csv**: Precipitation data (P) in millimeters (mm).
- **e.csv**: Vapor pressure data (e) in kilopascals (kPa).
- **u2.csv**: Wind speed data at 2 meters above the surface in meters per second (m/s).
- **S_in.csv**: Solar radiation data (S_in) in watts per square meter (W/m^2).
- **Temp.csv**: Temperature data (Temp) in Celsius.
- **Lat_Lon_Area_Z.csv**: Latitude, longitude, area (m2), and elevation data (m)

The code Lab2.m performs the following tasks: It begins by loading input data from CSV files, including streamflow (Q), precipitation (P), vapor pressure (e), wind speed (u2), solar radiation (S_in), temperature (Temp), and geographical information (Lat_Lon_A_Z). Then, it generates potential evapotranspiration (PET) using

meteorological data and auxiliary functions. The script further conducts a hydrological model simulation using the generated PET and precipitation data, along with user-defined parameters (using the function toymodel.m). Finally, it plots observed and simulated streamflow, as well as the relative storage of the unsaturated zone and actual evapotranspiration (ET) over time. This script provides a basic workflow for ecohydrological analysis, from data processing to model simulation and visualization.

The MATLAB function Rso_calc calculates the extraterrestrial solar radiation (Ra) and clear-sky solar radiation (Rso) based on provided input parameters. Rso was used with S_in to compute the factor f and calculate Net longwave radiation in a simplified way, following Equation 5.22 from the book.

The hydrologic model has 4 parameters (see slides for reference):

1. **PAR(1) - Maximum Infiltration Rate (Io)**: This parameter,represents the maximum rate at which water can infiltrate into the soil, measured in millimeters per day.
2. **PAR(2) - Su_max (Total Water Capacity)**: This parameter representing the total water storage capacity of the unsaturated zone in the soil, measured in millimeters. Su_max determines the maximum amount of water that the soil can retain before reaching saturation.
3. **PAR(3) - Ts Time (Parameter for Slowflow)**: This parameter represents the characteristic time for slow flow processes within the watershed, measured in days.
4. **PAR(4) - Tf Time (Parameter for Quickflow)**: This parameter represents the characteristic time for quick flow processes, measured in days.

For this first part of Lab2, you should arrive at the following figure, obtained from the simulation of Catchment #13 (Williams River, WV), from days 500 through 800, using PAR(1) = 50, PAR(2) = 450, PAR(3) = 5, and PAR(4) = 1: