

Exercise week 5 – Evapotranspiration

Goal

Estimate the potential evapotranspiration for the reference crop ET_0 in the Pully area based on the FAO Penman-Monteith (FAO-PM) equation and meteorological data.

Exercise 1, on paper

1. **Question:** Look at the formula of the FAO-PM equation: which variables need to be computed before implementing the equation? Which measurements are needed? What are the units of the different terms? Search among the content of Lecture 4 to find all the formulas and their units.
2. **Task:** Compute ET_0 for a hypothetical day where: net radiation $R_n = 150 \text{ W/m}^2$, wind direction $\phi = 25^\circ 12'$, temperature $T = 18^\circ \text{ C}$, wind speed at 2 meters $u_2 = 1.8 \text{ m/s}$, number of sunshine hours $n = 9$, altitude $l = 420 \text{ m}$ above sea level, heat losses to the ground $G = 0 \text{ W/m}^2$, relative humidity $R_h = 88\%$, precipitation depth $h = 2 \text{ mm}$. Note: not all this data is needed to implement the equation.

Exercise 2, on a computer

1. **Task:** Import the meteorological data downloaded from MeteoSwiss for year 2019. Check the metadata to see which variables are provided. Part of this is already done in the template.
2. **Task:** Display meteorologic data in a plot.
3. **Task:** Compute a simplified net radiation as $R_n = k R_g (1 - \alpha)$ where R_g is the global shortwave radiation provided by MeteoSwiss, α is the albedo of the reference crop and k is a reduction coefficient that we assume equal to 0.9.
4. **Task:** Compute ET_0 in mm/h for the entire year 2019 using the FAO-PM equation. Assume that heat losses to the ground G are negligible. Remember to check the consistency of the units.
5. **Task:** Compute the total ET_0 (in units of mm) for each month.
6. **Task:** Take the hourly ET_0 during February and August only. For each of these two months, plot the daily evolution of ET_0 during each day (see example Figure 1). Also add the mean month evolution. *Hint: use the function `reshape` to convert a vector of length 744 (which is $24 * 31$) into a matrix of size 24×31 .*
7. **Question:** What are the main differences in ET_0 between February and August ? Why?
8. **Optional Question:** ET can be seen as the sum of a radiation-induced ET and a turbulence-induced ET . Which component is stronger in this dataset?

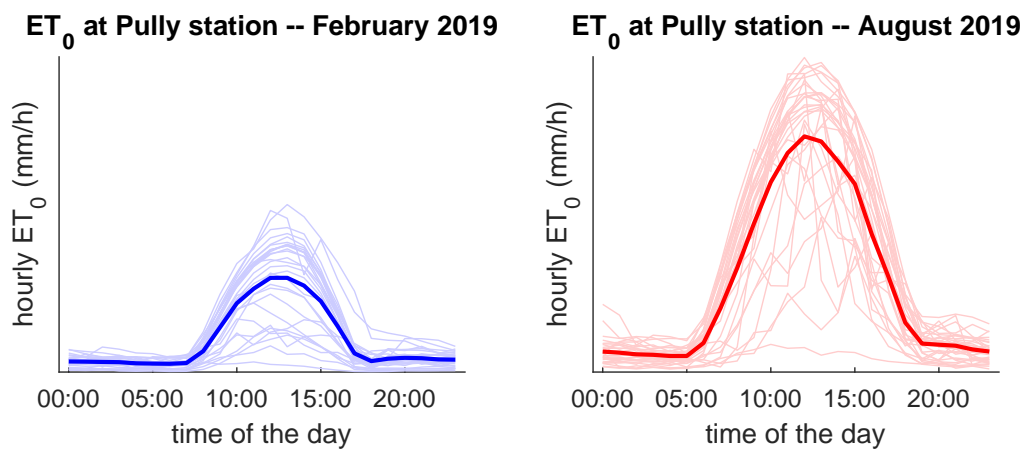


Figure 1: Example of ET_0 daily evolution for the months of February and August. Thin lines indicate ET_0 during each day; thick lines indicate the monthly mean.