

# Exercise week 5 – Evapotranspiration

## Goal

Estimate the potential evapotranspiration for the reference crop  $ET_0$  in the Pulley 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,  $\alpha$  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  $\text{mm/h}$  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  $24 \times 31$ ) into a matrix of size  $24 \times 31$ .*
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?

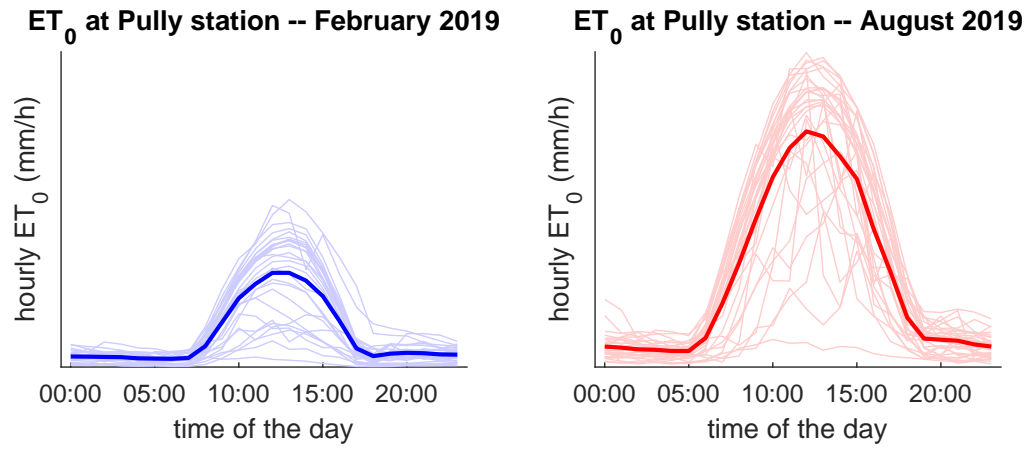


Figure 1: Example of  $ET_0$  daily evolution for the months of February and August. Thin lines indicate  $ET_0$  during each day; thick lines indicate the monthly mean.