

Lecture 2 – Exercises

Exercise 1: Wind speed

The wind rose at Lausanne airport from 2009 to 2016 is shown in Fig. 1. The median wind speed measured at 20 m above ground (above the urban elements) is $\bar{u} = 2.0 \frac{m}{s}$.

1. What is the predominant wind direction?
2. Determine the wind speed at the pedestrian height of 1.5 m above ground

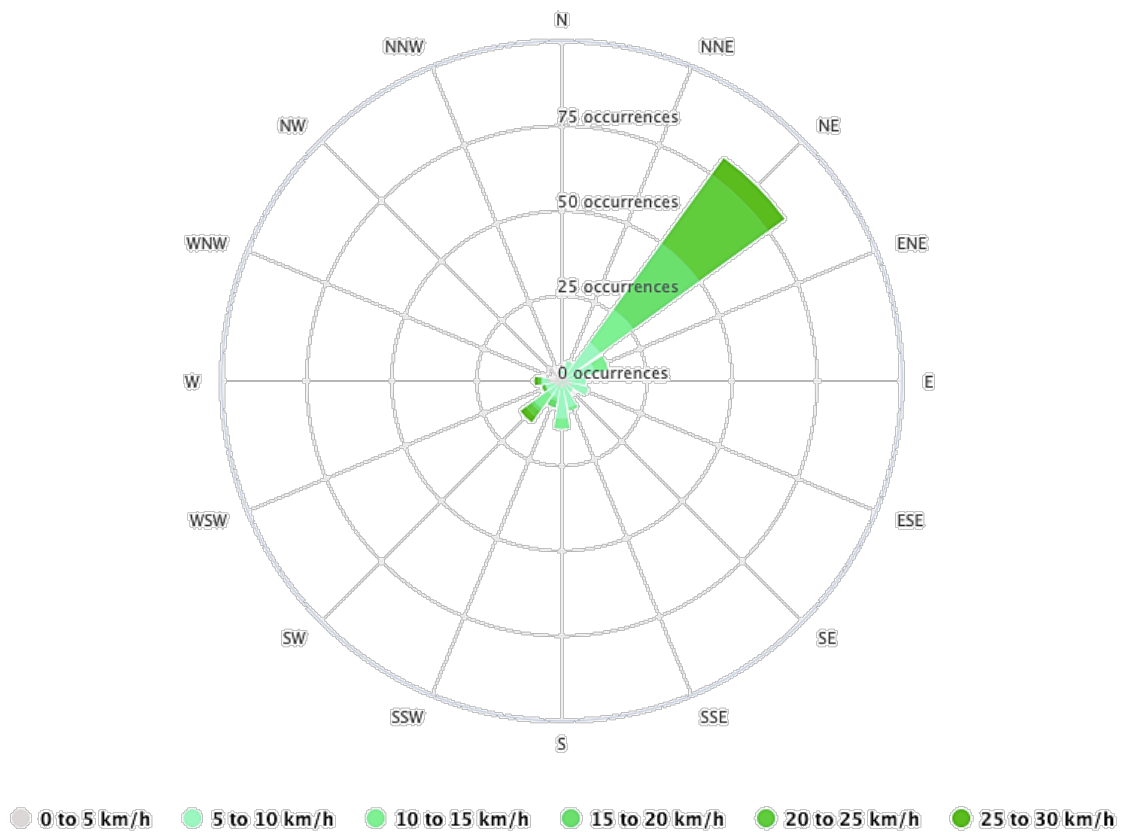


Figure 1: Wind rose, airport Lausanne (2009-2016), from <https://www.meteoblue.com>

Exercise 2: Temperatures

Consider a cobblestone pavement at the EPFL campus (on Avenue Piccard shown in Fig. 2).

1. On a clear summer afternoon (e.g., at 15-16 o'clock), would the surface temperature of the pavement be higher or lower than the air temperature? What would be the case in the early morning (e.g., at 6 o'clock)? Explain the physical processes involved.
2. In the summer, would the deep ground temperature (\sim at 10m depth) be higher than the air temperature?



Figure 2: Av. Piccard, EPFL campus

Exercise 3: Psychometrics

Evaporative cooling is a very common low-cost measure to cool not only indoors but also outdoor spaces. It is an adiabatic process with no change in the amount of energy (isoenthalpic process) in the air occurring at constant wet-bulb temperature. At atmospheric pressure of 101.3 kPa, determine if it is possible to cool air down to 24°C if the initial outdoor air temperature is 35°C, and relative humidity is $\phi = 20\%$.

1. Determine the relative humidity of air at 24°C. Would it be within the *comfortable range* of 40-60%?
2. How much water needs to be added in $\frac{g}{kg \text{ of dry air}}$ and in $\frac{g}{m^3}$ to cool the air?
3. Would evaporative cooling be efficient if outdoor air is 35°C but $\phi > 20\%$?
4. Could a standard psychometric chart be used to answer questions (1)-(3) if atmospheric pressure were 96 kPa (atmospheric pressure at the EPFL campus in the summer)?