The Penman equation can be used to estimate potential ET when \( Q_v \) and \( Q_\theta \) are negligible.

\[
E_0 = \frac{100Q_n \Delta + E_a \gamma}{\rho L} = \frac{\Delta + \gamma}{\Delta + \gamma}
\]

where \( \gamma = 0.66 \) [mb °C⁻¹], called psychrometric constant.
\( \Delta = \) slope of the \( e_{sa} - T_a \) curve (see DL, Fig. 4-8)
\( \rho = \) density of liquid water (1000 kg m⁻³)
\( L = \) latent heat of vaporization (2.46 × 10⁶ J kg⁻¹)
\( E_a = \) aerodynamic evaporation (cm d⁻¹), see below.

To account for the effects of cover types on the turbulent mass transfer, Van Bavel formula can be used to calculate \( E_a \).

\[
E_a = \frac{3.64 \ u_a (e_{sa} - e_a)}{T_a \ \left[ \ln \left( \frac{z_a}{z_0} \right) \right]^2}
\]

\( T_a, e_a \): air temp. (K) and vapor press. (mb) measured at \( z_a \)
\( e_{sa} \): saturation vapor pressure corresponding to \( T_a \)
\( z_0 \): aerodynamic “roughness” length
\( u_a \): wind speed (km/d) measured at \( z_a \)

The roughness length reflects the cover type. It is assumed to be about 1/10 of the vegetation height.

Compare this to the purely empirical Penman’s formula for \( E_a \) (page 4-14).
Temperature-based method for potential ET

Assumption: Potential ET is a function of air temperature alone.

What is the basis?

Limitations?

Thornthwaite method

Originally developed as an index for classifying climate.

Assumptions:

1. Air temperature represents the integrated effects of radiation and other controls (wind, humidity, vegetation, soil, etc.)
2. Bowen ratio is fixed.

\[
E_t = 1.6 \left( \frac{10T_a}{I} \right)^a \text{ (cm month}\^{-1}\text{)}
\]

\[
T_a = \text{mean monthly air temperature (°C)}
\]

\[
I = \text{annual heat index} = \sum_{i=1}^{12} \left( \frac{T_{ai}}{5} \right)^{1.5}
\]

\[
T_{ai} = \text{mean air temperature of the } i\text{-th month (°C)}
\]

\[
a = 0.49 + 0.0179I - 7.71 \times 10^{-5} I^2 + 6.75 \times 10^{-7} I^3
\]

Potential ET = \(c \ E_t\)

\(c = \text{correction factor for monthly sunshine duration (see DL, Table 5-2)}\)