Unit 17 Physical Hydrometeorology Applications

1. All students: Assume a 0.91 m deep root layer, d_r. The volumetric water content at field capacity θ_f and permanent wilting point θ_{pwd} are 0.31 m^3m^{-3} and 0.14 m^3m^{-3}, respectively. Wheat has a mean rooting depth of about 1.22 m. The management allowed deficiency (MAD) for wheat is 0.55.
    a. Identify the kind of soil.
    b. Calculate the plant available water d_{paw}.
    c. Graduate students: Readily available water $d_{raw}=MAD \cdot d_r$ is the water that a plant can easily extract from the soil. It is the soil moisture between field capacity and a nominated refill point for unrestricted growth. In this range of soil volumetric water, plants are neither waterlogged nor water-stressed. What is the readily available water if wheat is being grown on the above soil?
2. All students: At a glacier lake in 1500 m height, air pressure, temperature, relative humidity and net radiation were 850 hPa, 22ºC, 46%, and 90 Wm^{-2}. Wind speed was 2.5 m/s. Surface roughness, $z_0=4 \cdot 10^{-4}$ m.
    a. Determine the density of the air, water vapor pressure, dew point, specific humidity.
    b. Under the assumption of a negligible heat flux into the lake calculate the evaporation using the Bowen ratio method and the Penman Monteith method. Explain and justify assumptions that you may have to make.
    c. Calculate evaporation under the assumption of a wind speed of 5 m/s for both methods.
    d. Calculate the evapotranspiration assuming grass.
    e. Graduate students: Discuss and explain your results.

Unit 17 Physical Hydrometeorology Solutions

Task #1

a) Loam

b)

$$d_{paw} = \left[\theta_f - \theta_{pwp}\right] \cdot d_r$$

$$d_{paw} = [0.31 - 0.14] \cdot 0.91 = 0.15\ m$$

c) $d_{raw} = \theta_{raw} \cdot \left[\theta_f - \theta_{pwp}\right] = 0.55 \cdot 0.17 = 0.0935\ m$

Task #2

$H = \frac{e}{e_s}$, $e_s = 6.1078 \exp\left(\frac{17.1T}{243+T}\right) = 6.1078 exp\left(\frac{17.1 \cdot 22}{243+22}\right) = 23.57\ hPa$, e= 10.84 hPa, $q_v = 0.622 \frac{e}{p-0.378e} = 0.008\ \frac{kg}{kg}$, $\rho = \frac{85000}{287 \cdot (273.15+22) \cdot (1+0.61 \cdot 0.008)} = 0.999 \frac{kg}{m^3}$, T_d~281.5K