1. In this problem, you will compare how relative humidity, dew point temperature, ambient water vapor pressure, and water vapor concentration vary with time. Use the data on the course website ivs_data.dat that was collected by our research group in 2009 at the Iowa Validation Site, a corn field southwest of campus. Also use ps3_1_template.m and timeconvert.m to get going.

(a) Plot ambient air temperature (which was measured a few meters above the vegetation canopy) versus time beginning on day of year 194 (July 13) and continuing through the end of day of year 197 (three days).

(b) Plot relative humidity (measured at the same height as air temperature) versus time for the same time period in another figure.

(c) Compute, then plot water vapor pressure and saturation water vapor pressure versus time in a new figure for the same time period. Suggestion: create a MATLAB function using (3.8) in Campbell and Norman, or use my function sat_vp.m on the course website. My function uses the following empirical expression:

\[ e_s = 101.325 \exp \left( \alpha t_R - \beta t_R^2 - \gamma t_R^3 - \delta t_R^4 \right) \]  

where \( t_R = 1 - 373.15/T \) with \( T \) in kelvin, \( \alpha = 13.3185, \beta = 1.9760, \gamma = 0.6445, \) and \( \delta = 0.1299. \)

(d) Compute, then plot water vapor concentration in terms of mole fraction versus time in another figure for the same time period. Use the expression for pressure given in Campbell and Norman and an elevation of 300 m above sea level.

(e) Compute, then plot water vapor concentration in terms of mass concentration versus time in another figure for the same time period.

(f) Compute, then plot dew point temperature and air temperature versus time in another figure for the same time period. Use (3.14) in Campbell and Norman or my function dp.m on the course website.
(g) Compare and contrast how relative humidity, water vapor pressure, water vapor concentration (in terms of both mole fraction and mass concentration), and dew point temperature vary with time.

i. Which variables have a significant diurnal variation?
ii. At what time during the diurnal cycle is each quantity maximum?
iii. At what time during the diurnal cycle is each quantity minimum?
iv. What likely occurred the morning of day of year 194 and 196?

A plot is required for each part 1a − 1f. I encourage you to use the sub-plot command in order to put several plots on the same figure. Please also include your m-file.

2. (a) What is the dew point temperature if the ambient temperature is 15°C and the relative humidity is 0.80?
(b) If the dew point temperature is 5°C, what is the ambient water vapor pressure?
(c) If the dew point temperature outside is −5°C, what is the relative humidity inside a house where the ambient temperature is 20°C? Assume the dew point temperature inside the house is also −5°C.

3. 3.5 in Campbell and Norman.
4. 3.6 in Campbell and Norman.
5. 4.3 in Campbell and Norman.
6. 4.4 in Campbell and Norman.
7. 4.5 in Campbell and Norman.
8. 4.6 in Campbell and Norman.
   (a) Why is ice, and not just cold, a threat to organisms?
   (b) Many organisms burrow deep into the ground to find warmer temperatures. But how do the insects in this article survive cold temperatures?
   (c) What do you think about possible research that could use knowledge gained from studying how fish and insects survive extreme cold to produce methods that could preserve human tissue for long periods of time, perhaps long enough so that future medical treatments could bring people back to life?