

Cloud Physics Lab

LAB 1: Thermodynamics Properties of Air

Introduction:

You will be required to calculate air properties for three different weather conditions. Given sets of 24 hours' worth of weather data, you will calculate and graph some air properties to draw conclusions about the relationships between the data. Finally, you will write a laboratory report of your results.

Objective:

The objective of this lab assignment is to determine how we can use weather data to study thermodynamics properties of air.

Theory:

The thermodynamics properties of air are:

- Potential temperature

$$\theta = T (1000 / p)^{R_d / C_p} \quad (1)$$

- Saturated water vapor pressure

$$E_s = E_o \exp\left(\frac{L}{R_v} \times \frac{T - T_o}{TT_o}\right) \quad (2)$$

- Saturated mixing ratio

$$r_s = (R_d / R_v) \left(\frac{E_s}{p - E_s} \right) \quad (3)$$

- Mixing ratio

$$r = (RH / 100) / r_s \quad (4)$$

- Virtual temperature

$$T_v = T(1 + 0.608r) \quad (5)$$

- Water vapor pressure

$$e = \frac{p \times r}{\varepsilon} \quad (6)$$

where:

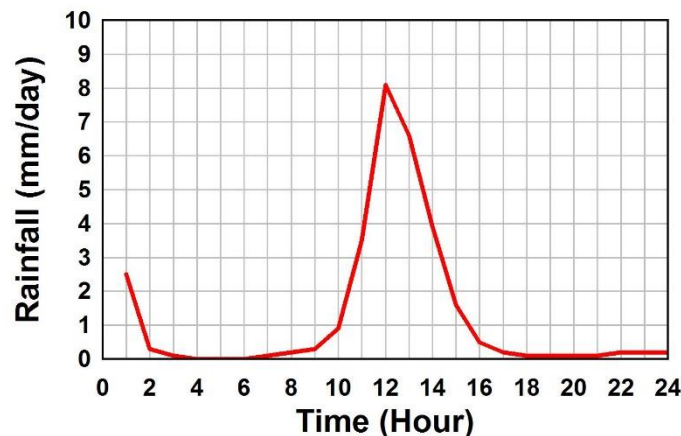
$$R_d=287.1 \text{ JK}^{-1}\text{kg}^{-1}, \quad R_v= 461.5 \text{ JK}^{-1}\text{kg}^{-1} \quad C_p=1004 \text{ JK}^{-1}\text{kg}^{-1}, \quad L=2500000 \text{ Jkg}^{-1}, \\ E_o=6.11 \text{ hPa}, \quad T_o=273.16 \text{ K} \quad \varepsilon = R_d / R_v = 0.622$$

Materials and Procedures:

1. Run the Matlab script **Lab1.m** to calculate and plot the air properties for the following weather observations
Case 1: weather observation for summer day (15 July 2015): Input file: **case1.txt**
Case 2: weather observation for clear mild day (18 Oct 2015): Input file: **case2.txt**
Case 3: weather observation for rainy day (28 Oct 2015): Input file: **case3.txt**
2. After running the script for each case, cut and past the **figure files** and the file **results.txt** into the corresponding folder of each case.
3. Use the attached word file **wtmp1.doc** to sum all figures of the three cases in one file.

Analysis and Conclusions:

1. For each case explain the profile of each variable with time.
2. Remember case 1 is dry condition; case 2 is clear condition for autumn day; and case 3 is rainy condition for autumn day. The rainfall data are plotted in the following diagram



Hourly rainfall (mm/hr) for 28 Oct. 2015

Questions:

1. What did you learn about air properties by completing the activity?
2. What is the relationship between temperature, saturated mixing ratio, saturated water vapor pressure, and relative humidity?
3. How weather condition affect the air properties?