Lab 2 for GEOL 1147 (Introduction to Meteorology Lab)

1. Use data in Lab2.xls to plot the vertical profiles for temperature and dewpoint temperature for Key West station on Dec 14, 2012. The following are the details for the sounding variables listed in Excel file.

- PRES (hPa): air pressure
- HGHT (m): height above sea level
- TEMP (ºC): air temperature in Celsius
- DWPT (ºC): dewpoint temperature, or dewpoint for short, also in Celsius: it is the temperature at which the air becomes saturated
- RELH (%): relative humidity, a relative measure of the water vapor content in the air. It is expressed as a percentage of the maximum (saturation) amount of water vapor in the air.
- MIXR (g/kg): the water vapor mixing ratio, the amount of water vapor (in grams) present in each kilogram of dry air)
- DRCT (deg): the wind direction: northerly (or from the north) is zero, an easterly wind is about 90, a southerly wind about 180, and a westerly wins is about 270. A northeasterly wind has DRCT of about 45 degrees, etc.
- SKNT (knots): the wind speed

Instruction: Plot temperature and dewpoint vs. height (scatterplot). In EXCEL, go to **insert Chart**, then **Scatter**, then choose **Smooth Marked Scatter**. Then click **Chart, Source Data**. Click on the small icon to the right of **x values**. This allows you to select the column in the spreadsheet pertaining to your x-axis. Then choose temperature for your x-axis (highlight all values in the TEMP column), and height for the y-axis (highlight all values in the HGHT column) using the same procedure in selecting HGHT values as you did TEMP. Give this series a name ('temperature') and **add** a second series. This time plot dewpoint (DWPT) on the x-axis, and again height (HGHT) on the y-axis. **Next** you can label the x- and y- axis and you can take various steps to improve the layout of the chart.

2.Identify the height for the tropopause from the figure obtained from problem 1.

3. Assume that the temperature is 20.2 °C at 0 m and the temperature is 15.6 °C at 1000 m. Calculate the rate of cooling with increasing height (the 'lapse rate' or LR, expressed in °C per km). Use the following formula for the rate of cooling with altitude (Z):

$$LR = \frac{-1000 * (T_{upper} - T_{lower})}{Z_{upper} - Z_{lower}}$$

Here T is temperature (TEMP) and Z height (HGHT). Add the UNITS to your numerical answer.

4. Calculate the lapse rate (*LR)* from the 6m to 5041m. Units for the lapse rate are °C/km. Here 'upper' refers to 5041 m and 'lower' refers to the first row listed in the Excel. Within EXCEL you can calculate the *LR*. Just pick and empty box below the data, and type in: =-1000*(click-click)/(click-click)
where each 'click' refers to a mouse-click on the box in the EXCEL sheet that contains the number you are looking for, starting with TEMP @ 5041 m.

5. Use Excel to calculate the lapse rate between 20090 m and 27127 m.

6. A positive lapse rate implies that the air temperature decreases with height. How could you determine the sign of the lapse rate by just looking at your temperature profile (without doing any calculations)?

7. Look at the temperature and dewpoint profiles on your figure from problem 1. Does the dewpoint at any height exceed the air temperature for the same height? Discuss what would happen if the dewpoint was larger than the temperature.

8. Generate a new XY (scatter) plot, but plot pressure (PRES) on the x-axis, and height (HGHT) on the y-axis. Again label the x- and y-axes of the plot appropriately, and draw a smooth line connecting the dots. Calculate the rate of decrease of pressure with height (dp/dz, expressed in hPa per km), using a similar formula as used for problem 3, but replacing the temperature values with pressure values:

$$\frac{dp}{dz} = \frac{1000 * (p_{upper} - p_{lower})}{(Z_{upper} - Z_{lower})}$$

a) dp/dz (1 km to 2 km, or the closest HGHT values to these):

b) dp/dz (9 km to 10 km, or the closest HGHT values to these):

c) Does the sign of the rate of decrease of pressure change with height?

d) How does the magnitude of the rate of change of pressure change with height? Why?

9. Generate a new XY (scatter) plot, but plot mixing ratio (MIXR) on the x-axis, and height (HGHT) on the y-axis. Again label the x- and y-axes of the plot appropriately, and draw a smooth line connecting the dots. How does the water vapor mixing ratio vary with height?

10. How much more water vapor is there near the surface, compared to layers in the upper troposphere? Hint: look at the column 'MIXR' in the EXCEL spreadsheet and find the highest value of MIXR, at or near the surface, as well as the lowest value near the tropopause.

highest value:

lowest value:

11. Generate a XY (scatter) plot for relative humidity (RELH) on the x-axis and height (HGHT) on the y-axis. Look at the column of relative humidity values (RELH). Does the relative humidity decrease as rapidly with height as the mixing ratio? Describe how the relative humidity varies: does the change in relative humidity mirror changes in mixing ratio, or do you still find high values of relative humidity at some levels in the middle and/or upper troposphere?

12. Generate a XY (scatter) plot for the *wind speed* (SKNT) on the x-axis and height (HGHT) on the y-axis. Describe how the *wind speed* (SKNT) **generally** varies with height from the surface up to the top of the sounding. In what region of the atmosphere does the sounding indicate the highest wind speeds?