ATSC 5010 – Physical Meteorology I Lab
Lab 7 – soundings, buoyancy, stability, moisture…

Today we will use the thermodynamic diagrams (pseudo-adiabatic charts) that we built last week. We will plot soundings on the charts and use the charts to address questions related to buoyancy, stability, cloud top, etc.

> Terms to define:
> CCL, MCL, Level of Free Convection, Buoyancy (positive, negative, neutral), MCL, Convective Temperature, stability (unstable, stable, neutral), Level of Neutral Buoyancy (for a rising parcel)

Exercise:

To plot a sounding, once your chart has been built, use the 'plot' function with the overplot keyword set. Plot the environmental temperature using a *thick black solid line* and the environmental dewpoint with a *thick black dotted line*.

Create a procedure called: "atsc5010_*yourname*_lab7"

Problem 1.
Produce a thermodynamic diagram using the procedure you built with lab 6. Plot the following sounding data on your thermodynamic diagram:

P (mb)	T (°C)	T_d (°C)
959	22.2	19.0
925	19.8	17.1
900	18.4	16.9
850	17.0	12.5
800	15.5	-11.4
700	7.0	-10.0
600	-4.2	-15.8
550	-10.3	-14.9
500	-14.9	-18.9
400	-26.7	-30.0

For questions 1-3, use "where" and other idl functions to determine the answers (you may want to estimate by hand to make sure you are on the right track).

1. Determine the potential temperature, mixing ratio, saturation mixing ratio and relative humidity for air parcels at 959, 900, 800 and 700 mb.

2. Starting with the parcel at 959 mb, lift it to 900 mb. Does it become saturated? If so, what is the LCL. What is $T' - T_{env}$ at 900 mb (T' is the parcel temperature, T_{env} is the environmental temperature)?

3. Lift the parcel from 959 mb to 800 mb. What is $T' - T_{env}$ at 800 mb?

For questions 4-7, answer by hand.

4. If we continue to lift this parcel, at what pressure level will the parcel become warmer than the environment? This is called the level of free convection.

5. Once a parcel reaches its "level of free convection" (in 4), explain how would one estimate how high the parcel would rise? Can it continue to rise if its temperature is less than the environmental temperature? Will the parcel in (4) reach 400 mb?

6. What factors act to reduce buoyancy in a freely-rising air parcel?

7. How does the atmospheric (environmental) lapse rate influence the parcel buoyancy?

Problem 2.
Produce a second thermodynamic diagram and plot the following sounding data on your chart:

early summer conditions in the Midwest:

P (mb)	T (°C)	T_d (°C)
980 (surface)	23.0	20.2
910	20.5	19.7
875	19.9	17.3
709	11.2	-4.6
400	-20.5	-25.0

1. For each level, determine the following: mixing ratio, saturation mixing ratio, relative humidity, wet bulb temperature, wet bulb potential temperature (*by hand and verify within your procedure*).

2. Determine (*by hand only*):
a) The LCL for a parcel of air at the surface (980 mb).
b) The level of free convection.
c) The CCL for this parcel.
d) The convective temperature.
e) The MCL if it is assumed that the layer between 980 hPa and 900 hPa is mixed.
f) The MCL if the layer between 980 hPa and 850 hPa is mixed.

For the next two problems, do by hand and verify within your procedure:

3. Assume for a moment that the atmosphere is dry (devoid of any water). Lift the surface parcel to 500 mb. What is the temperature difference $T' - T_{env}$ (Use T_{env} = -8C)? Is the buoyancy of the dry parcel positive, negative, or neutral?

4. Now consider the effects of moisture. Lift the surface parcel (this is parcel at 980 mb, with T=23.0C & Td=20.2C) to 500 mb, allowing condensation to occur. What is the temperature difference $T' - T_{env}$ at 500 mb? Is the buoyancy of the now saturated parcel positive, negative, or neutral?

This is an extreme example of conditional instability. The parcel is unstable if sufficient moisture is present in lower layers for condensation to form and the lapse rate is greater than the moist adiabatic rate.

For the next problem, do by hand:

5. For the sounding on your thermodynamic diagram, determine the mixing ratio necessary for the surface parcel to have, such that, if lifted to 500 hPa, it would have the same temperature as its surroundings (neutral buoyancy).