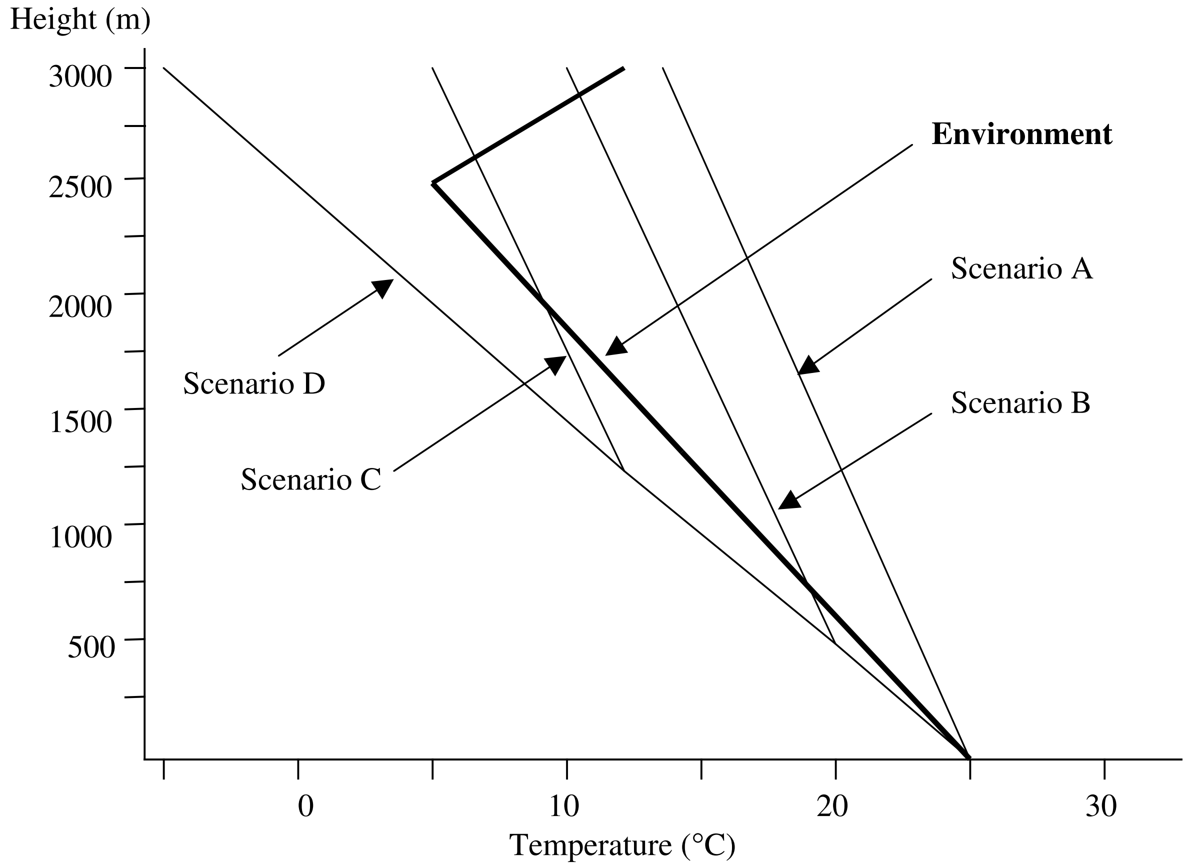
Atmospheric Sciences 101

Homework Assignment # 5 (assigned 2/11/99, due beginning of class 2/18/99)



1.The heavy black line in the figure above represents the temperature structure in the lower atmosphere (the **environmental** lapse rate) on a summer day. Note that the environmental temperature decreases with height (at a lapse rate of about -8°C/km) from the surface up to 2500 meters, then there is a temperature inversion from 2500-3000 meters. Suppose we have a parcel of air at the surface that gets lifted up through the atmosphere (don't worry about *how* the parcel is lifted, we will talk about this later). Consider four different scenarios for this parcel.

Scenario A: the parcel initially has a relative humidity of 100%. When it rises, condensation occurs immediately and the parcel rises at the moist adiabatic lapse rate through the entire layer from 0-3000 meters.

Scenario B: the parcel initially has a relative humidity of 80%. When it rises, it first cools at the dry adiabatic lapse rate. When it reaches 500 meters, the air becomes saturated, and as it rises further the parcel cools at the moist adiabatic lapse rate.

Scenario C: the parcel initially has a relative humidity of 60%. The parcel cools at the dry adiabatic lapse rate for the first 1250 meters, then moist adiabatically as it rises above this point.

Scenario D: the parcel initially has a relative humidity of 10%. It does not become saturated as it is lifted through this layer up to 3000 m.

For each scenario above, answer the following questions:

i) What would be the altitude of the cloud *base* for this scenario (if any)?

ii) What would be the altitude of the cloud *top* (if any)?

iii) Where will the parcel be warmer than the surrounding environment? Colder?

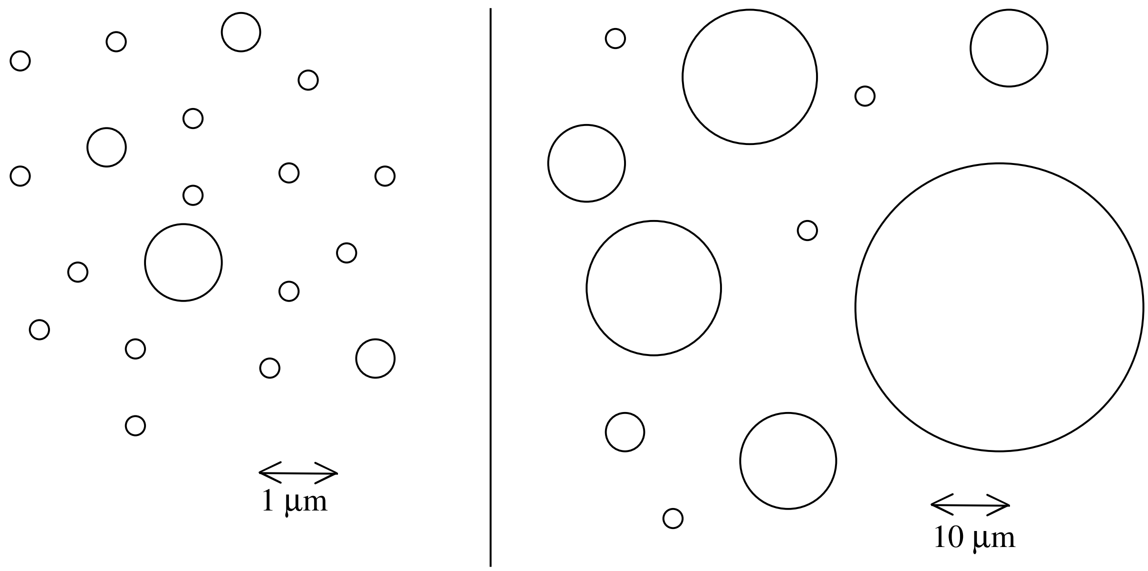
iv) Based on (iii), where is the parcel less dense than the environment? More dense?

v) If a parcel is less dense than its surroundings, it will be *buoyant* (it can rise without the help of any lifting mechanism). Based on (iv), where would you expect this parcel to be buoyant?

vi) Would you call this scenario stable, unstable, or conditionally unstable?

2. In a few sentences of **your own words**, explain how each of the following types of fog form near the surface of the Earth. Be sure to include the time of year and the atmospheric conditions that are required:
a) advection fog
b) steam fog
c) radiation fog

3) The following two pictures represent different samples of liquid cloud droplets.



a) The sample on the left was obtained on the roof of the Space Needle. What kind of cloud would you expect to see in the sky? Why? What kind of precipitation would you expect? Why?
b) The sample on the right was obtained from an airplane flying over Seattle at 5000 meters. What kind of cloud would you expect to see in the sky? Why? What kind of precipitation? Why?
c) Would you ever expect to see the sample on the left at an altitude of 5000 meters? Under what conditions? At 10,000 meters?
d) Would you expect to see the sample on the right at 10,000 meters? Under what conditions?

4) Cloud Journal mini-project:
On Monday, February 15th, Tuesday, February 16th, and Wednesday, February 17th, 1999, answer the following questions about the weather outside (if you are out of town on one these days at 11:30 a.m., describe the clouds where you are and draw a quick sketch).
a) What is the approximate temperature outside?
b) Is there any precipitation? If so, is it rain, drizzle, snow, or something else?
c) What direction is the wind blowing **from** at the surface? Estimate the wind speed. (See page 149 in the book to see how you should express wind direction)
d) What percentage of the sky is covered with clouds?
e) What type(s) of cloud(s) do you see in the sky? Look in the back of the textbook or ask us if you need help naming the clouds.
f) Are the clouds that you see high clouds, middle clouds, or low clouds?
g) Based on the direction that the clouds are moving, what do you think the wind direction at the level of the clouds is (again, use page 149). Are the clouds stationary, moving slowly, moving fast, or moving really, really fast? Do you think the wind is stronger at the surface or aloft?

5) Pick two of the following review questions from Chapter 15 in the book and answer them in a paragraph or less (use your **own words** and **include a diagram**): 5, 11, 13, 14, 18, 19.